

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

1/72

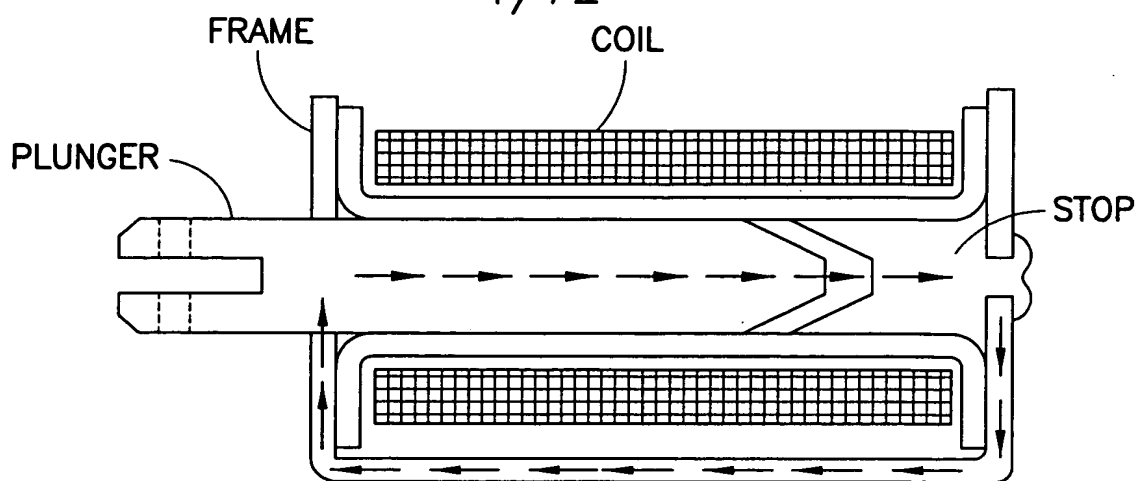


FIG. 1A

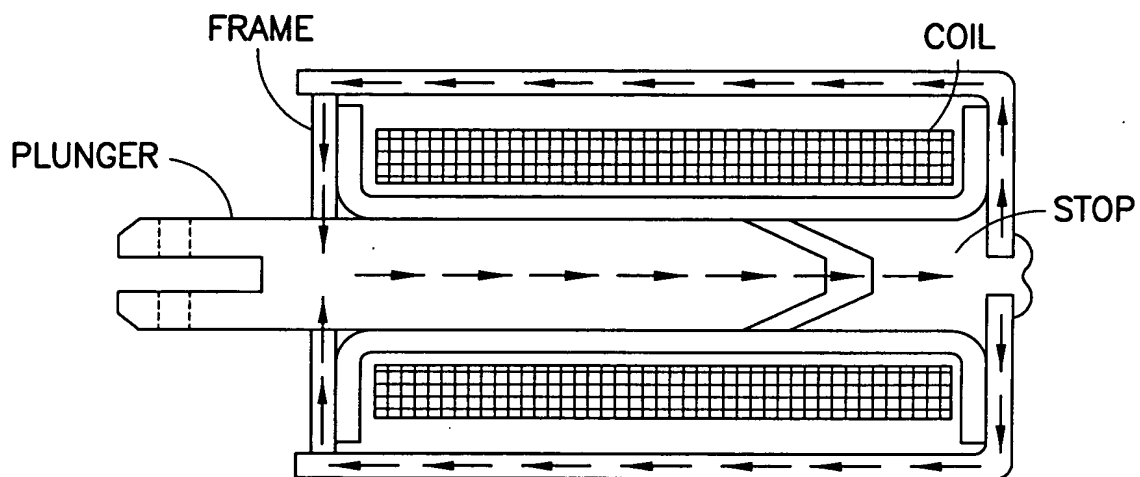


FIG. 1B

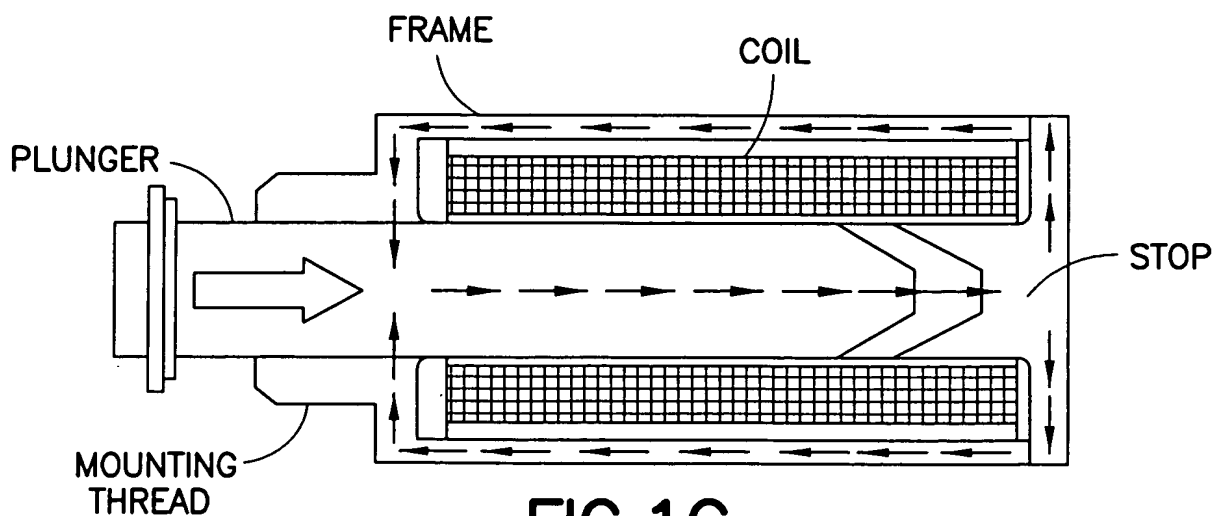


FIG. 1C

2/72

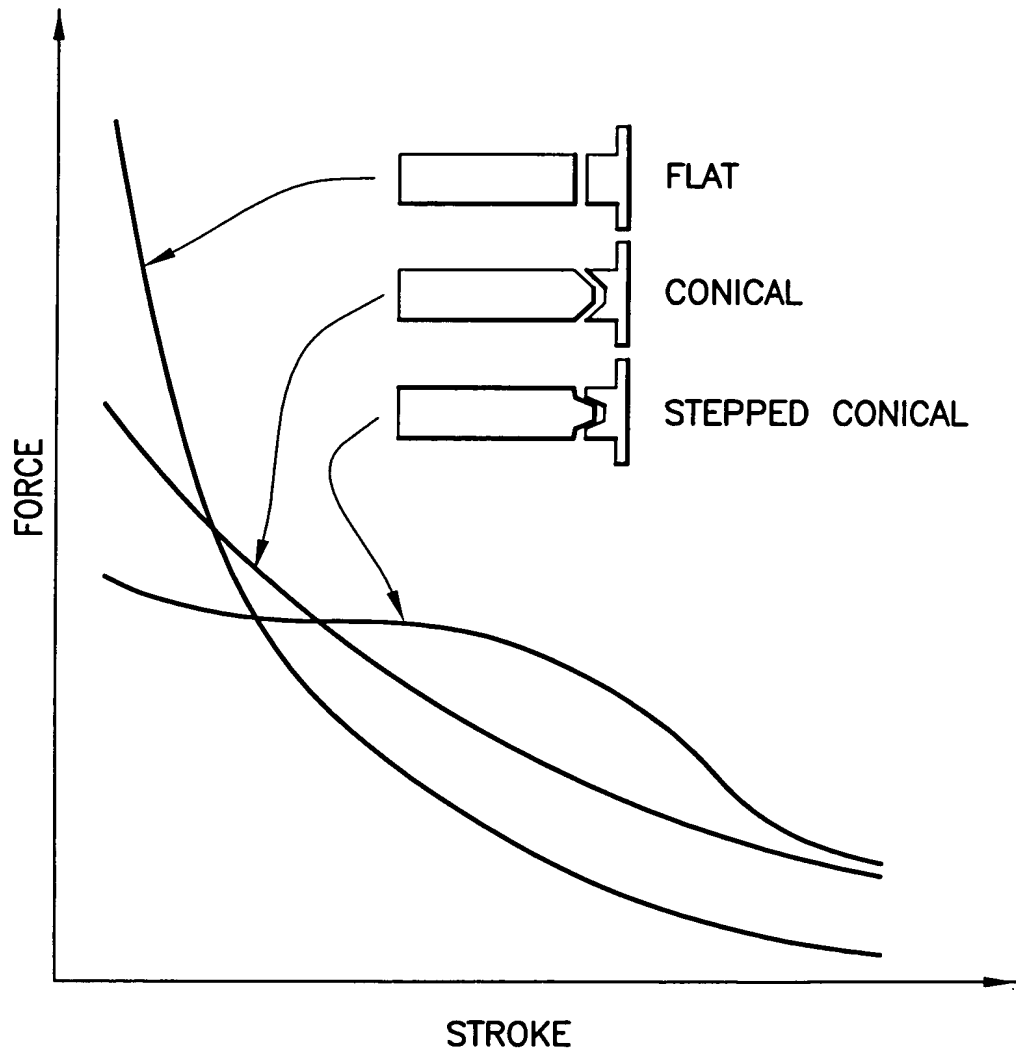
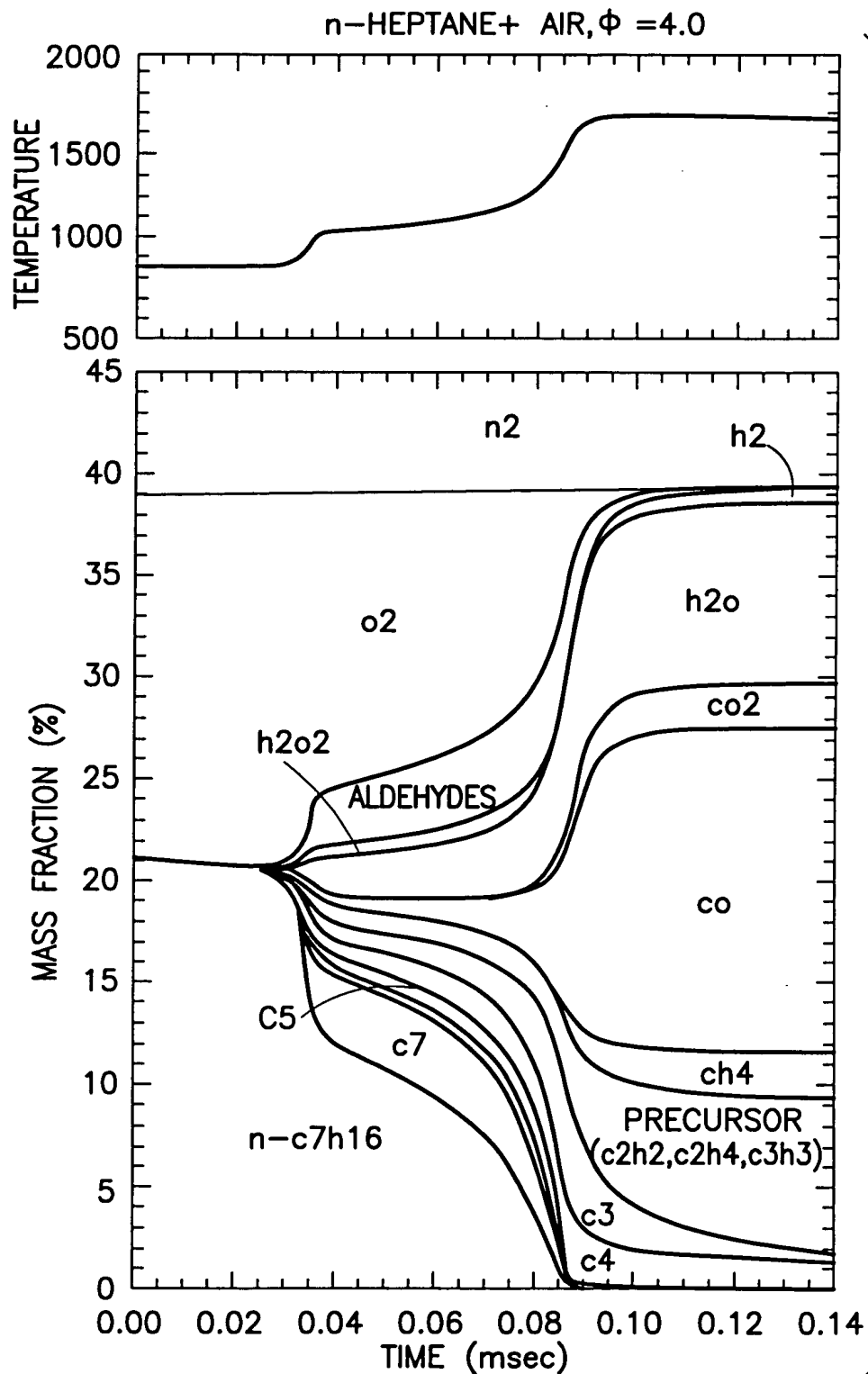


FIG.2

3/72



NORMAL HEPTANE REACTIONS STARTING
AT 900 °K AND 83 BAR

FIG.3

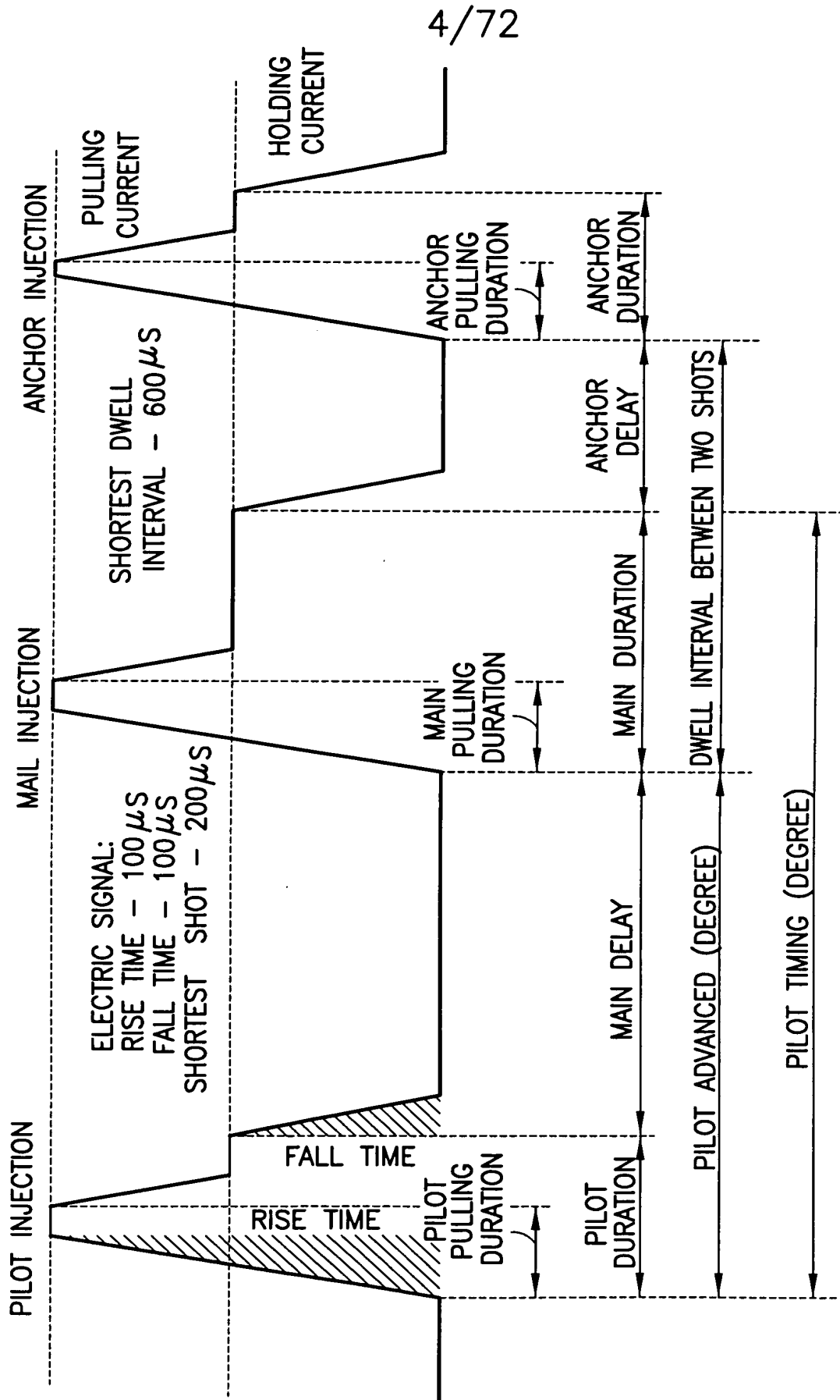


FIG.4

5/72

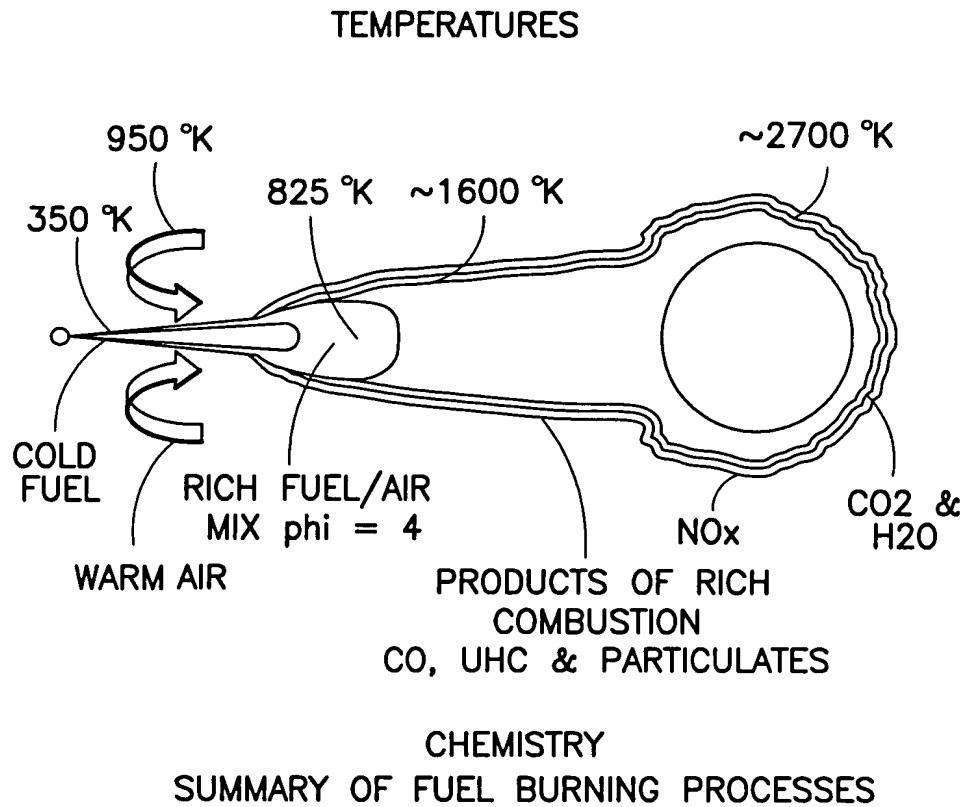


FIG.5

6/72

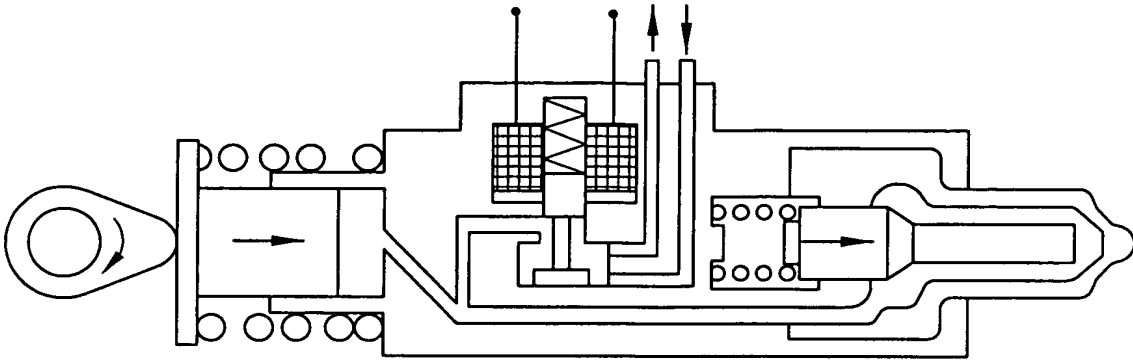


FIG. 6D

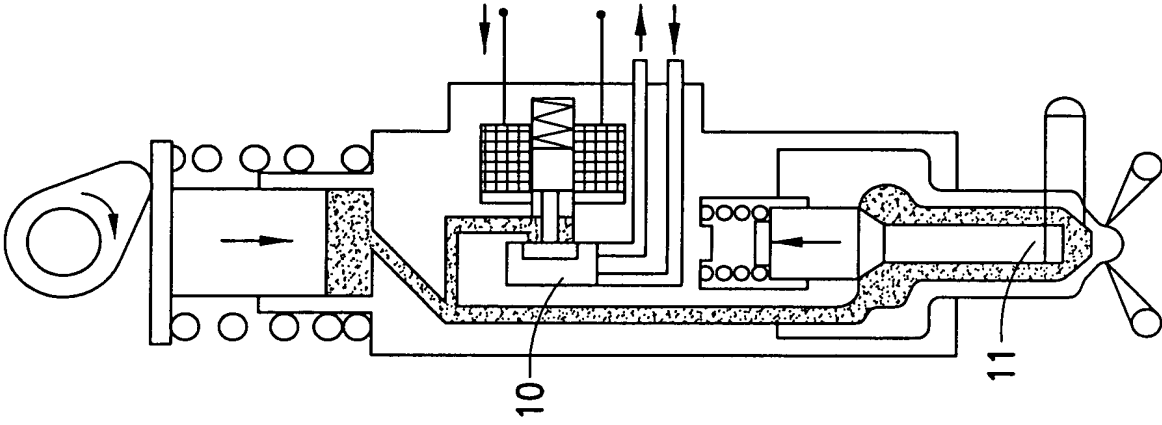


FIG. 6C

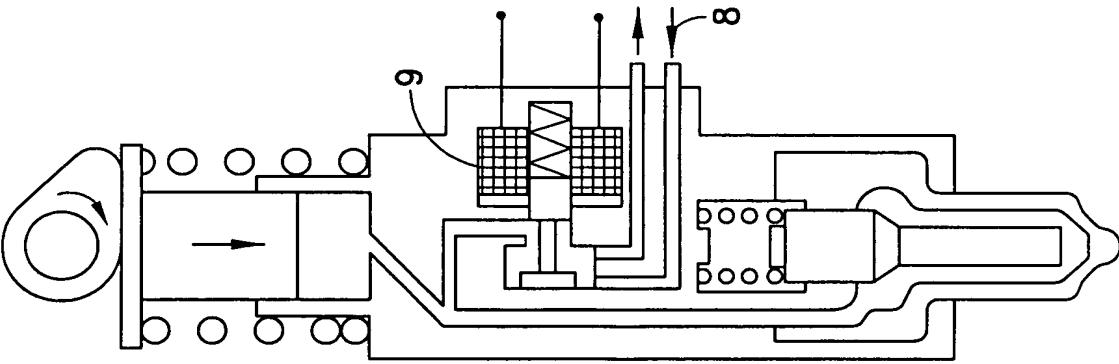


FIG. 6B

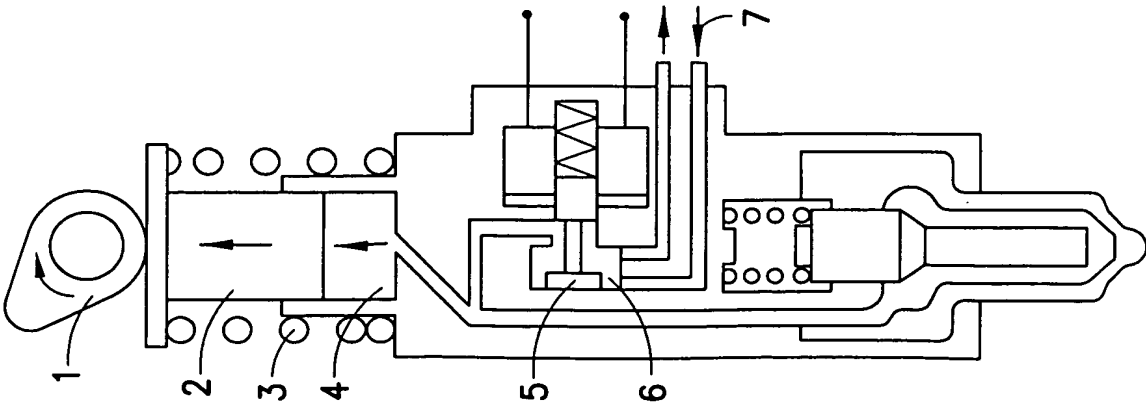


FIG. 6A

7/72

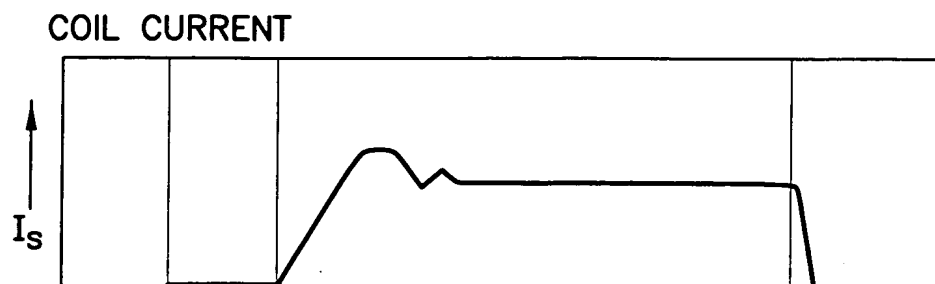


FIG.7A

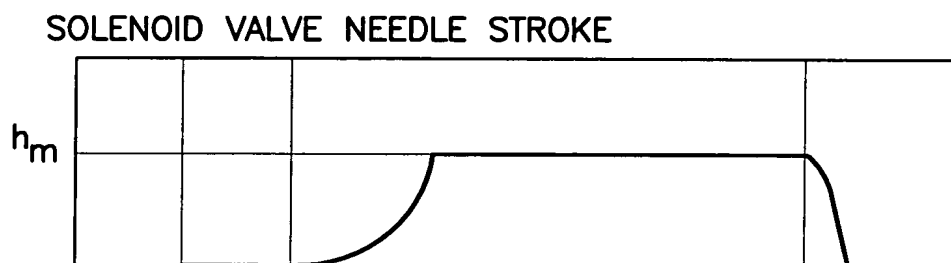


FIG.7B

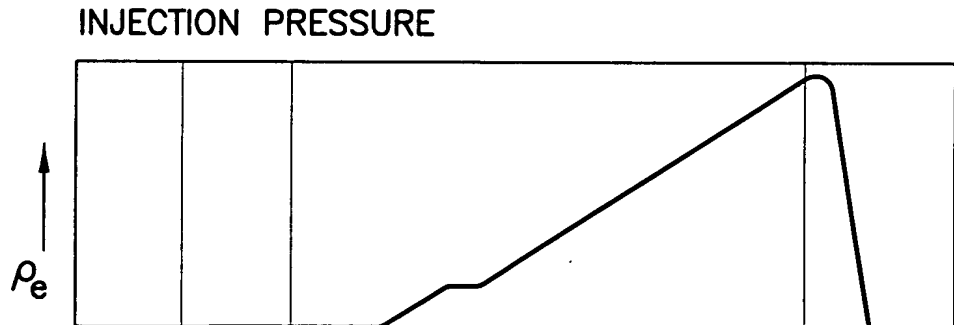


FIG.7C

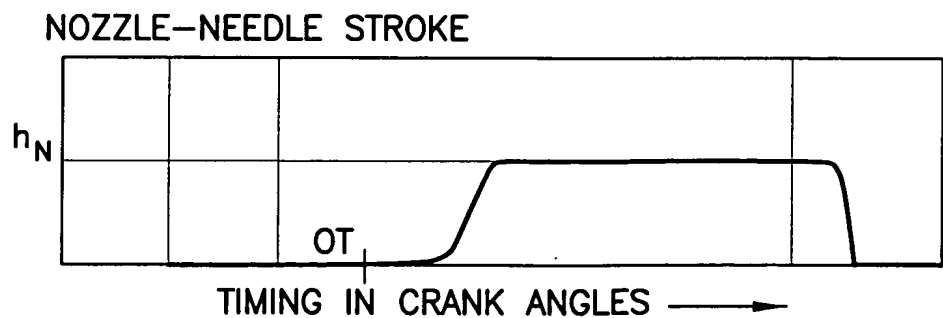


FIG.7D

8/72

WAVE FORM DIAGRAM: OPERATION OF THE FUEL INJECTION NOZZLE

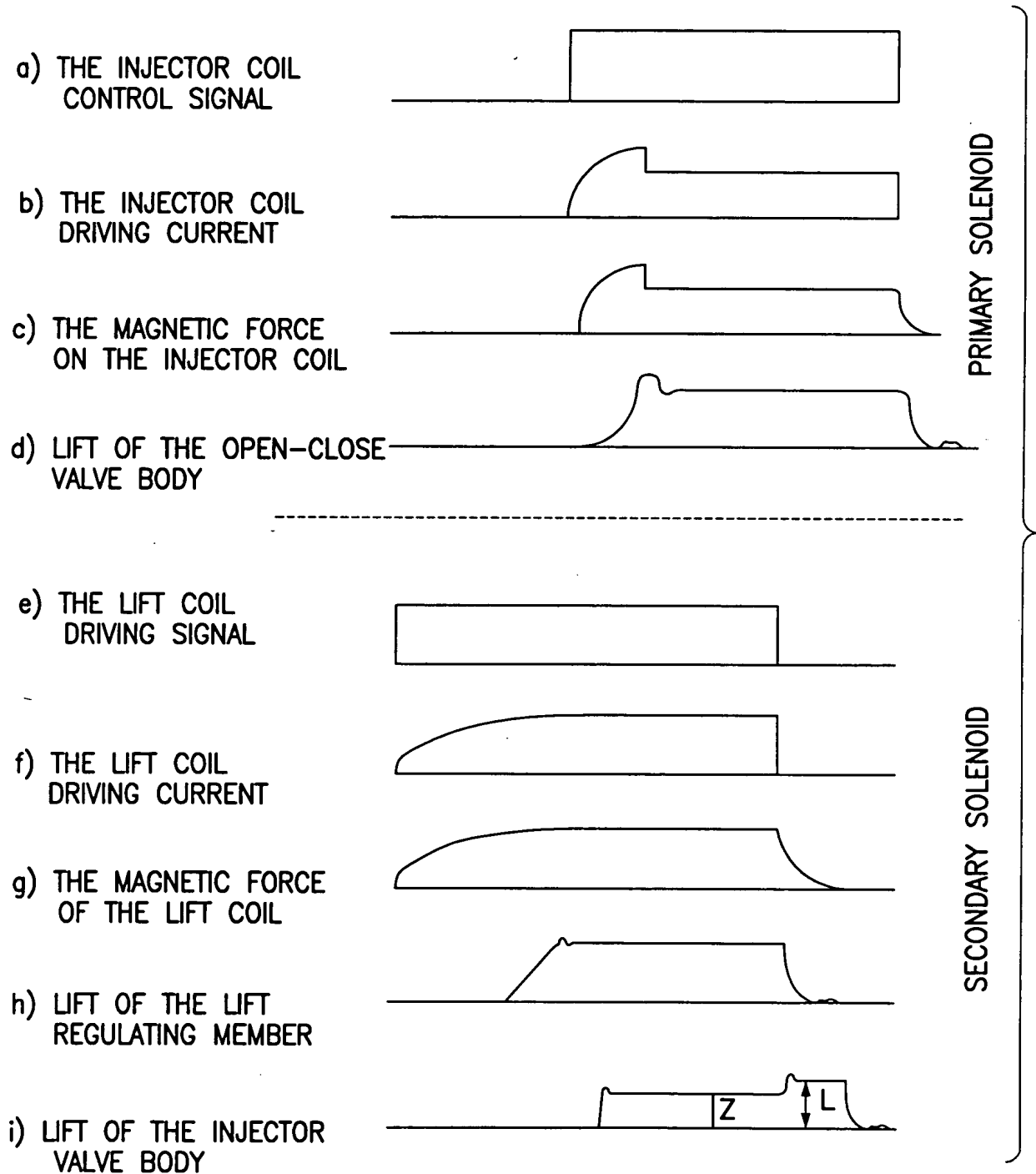


FIG.8

9/72

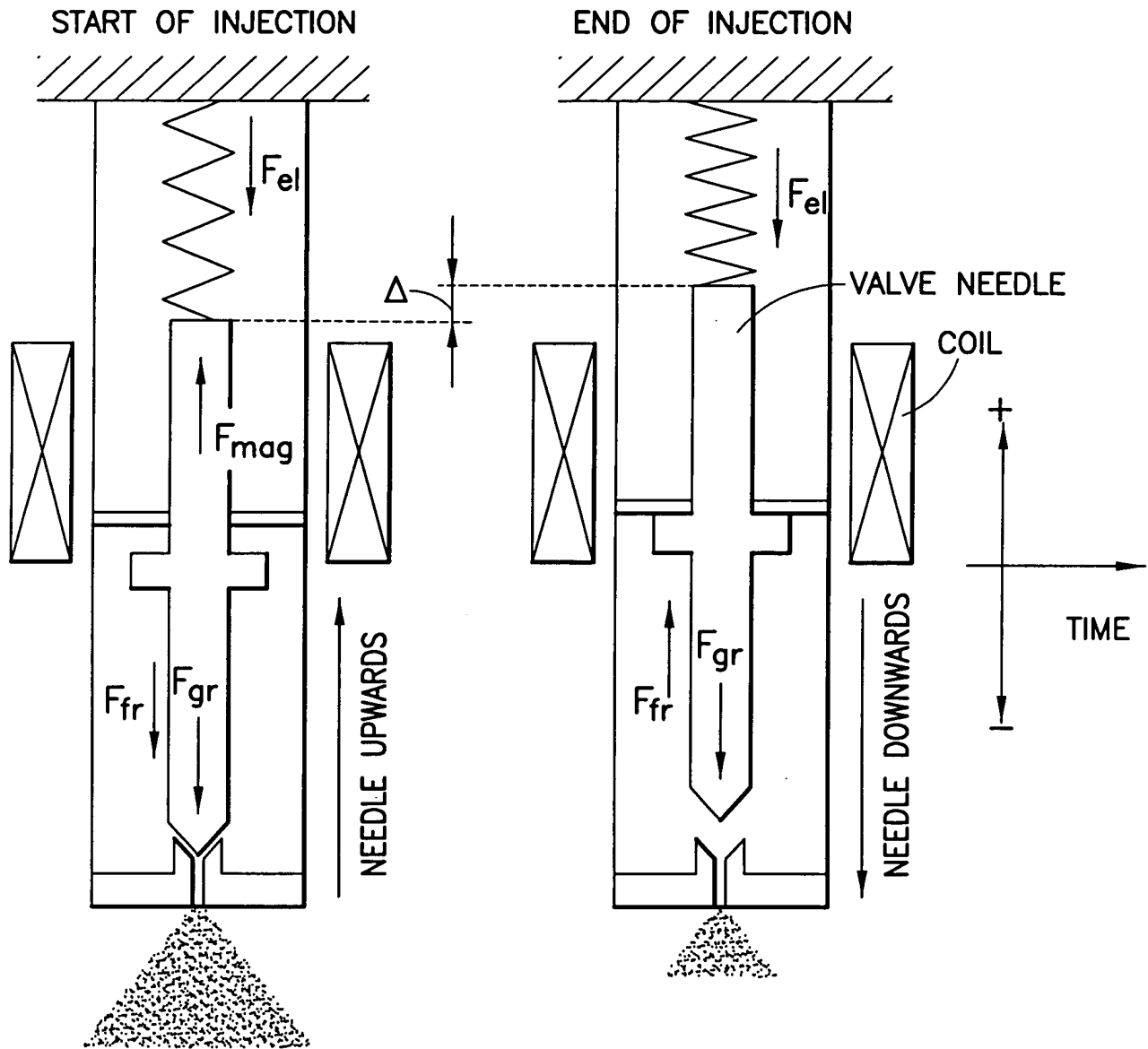


FIG.9

10/72

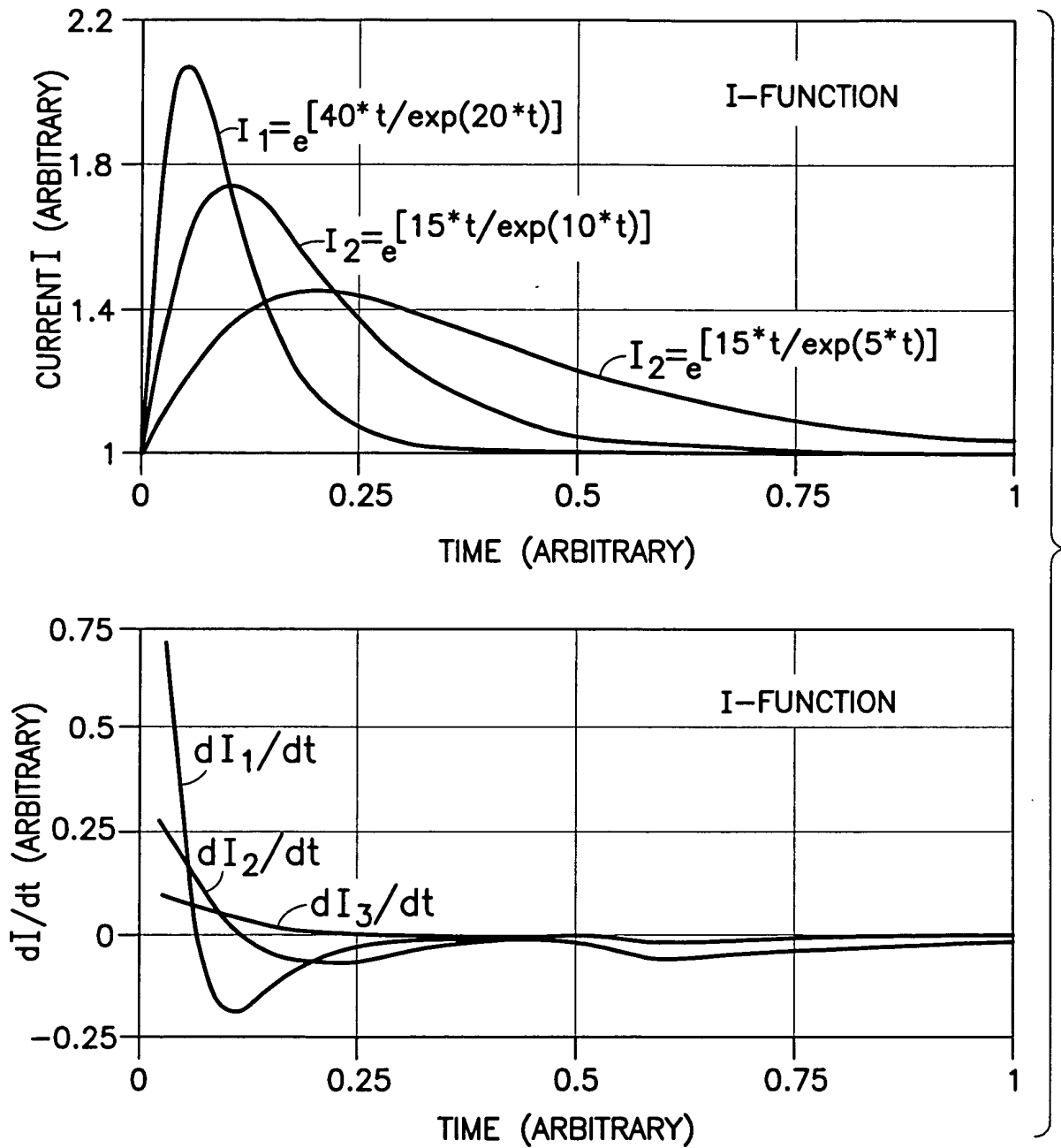


FIG.10

11/72

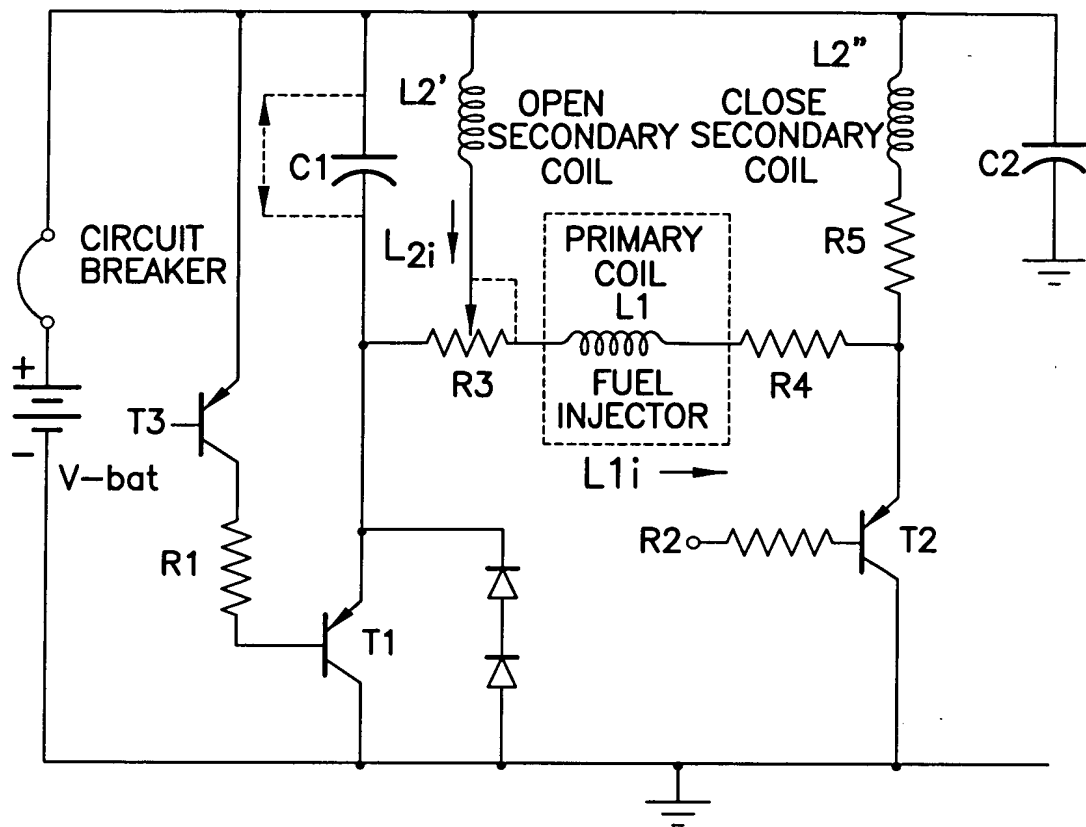


FIG. 11A

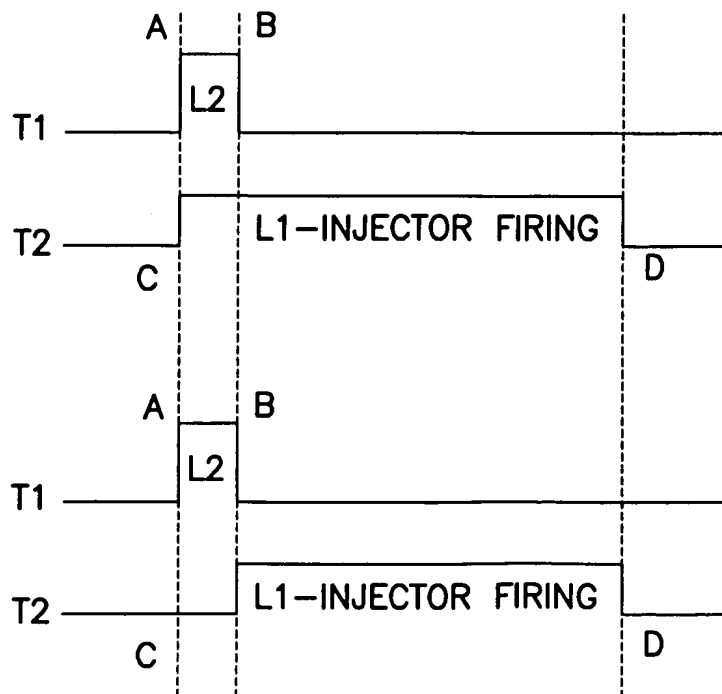


FIG. 11B

12/72

SIMULTANEOUSLY CHARGED SECONDARY COIL: $f=40\text{Hz}$
A=T, B=C, C=A+CHARGE, D=C+INJ. DURATION

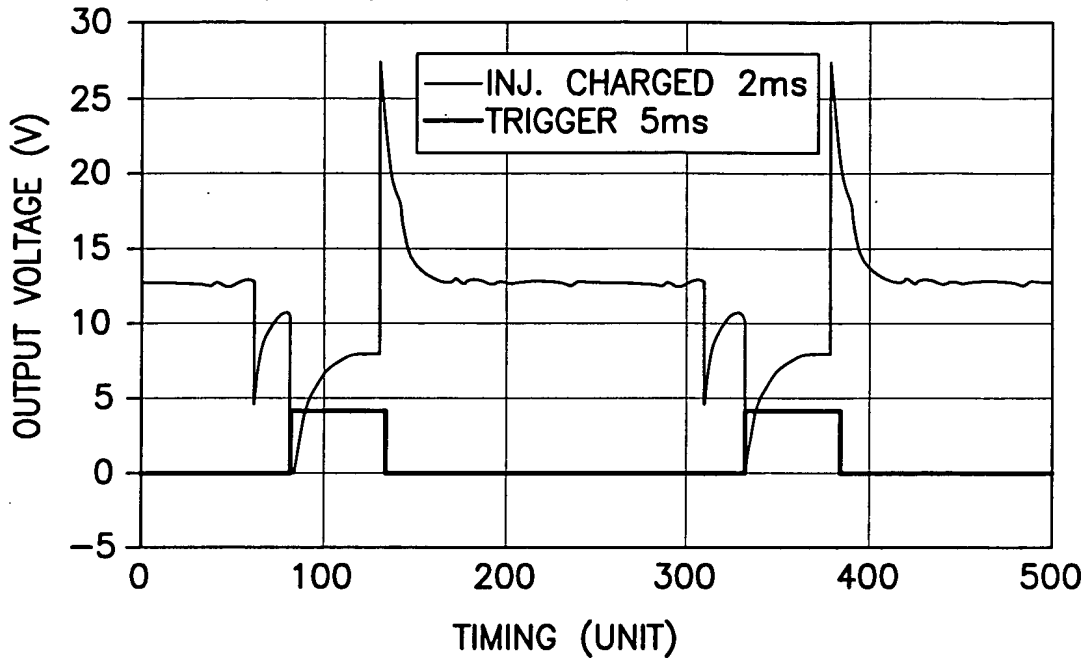


FIG.12A

PRECHARGED SECONDARY COIL: $f=40\text{Hz}$
A=T, B=A+CHARGE TIME, C=A, D=C+INJ. DURATION

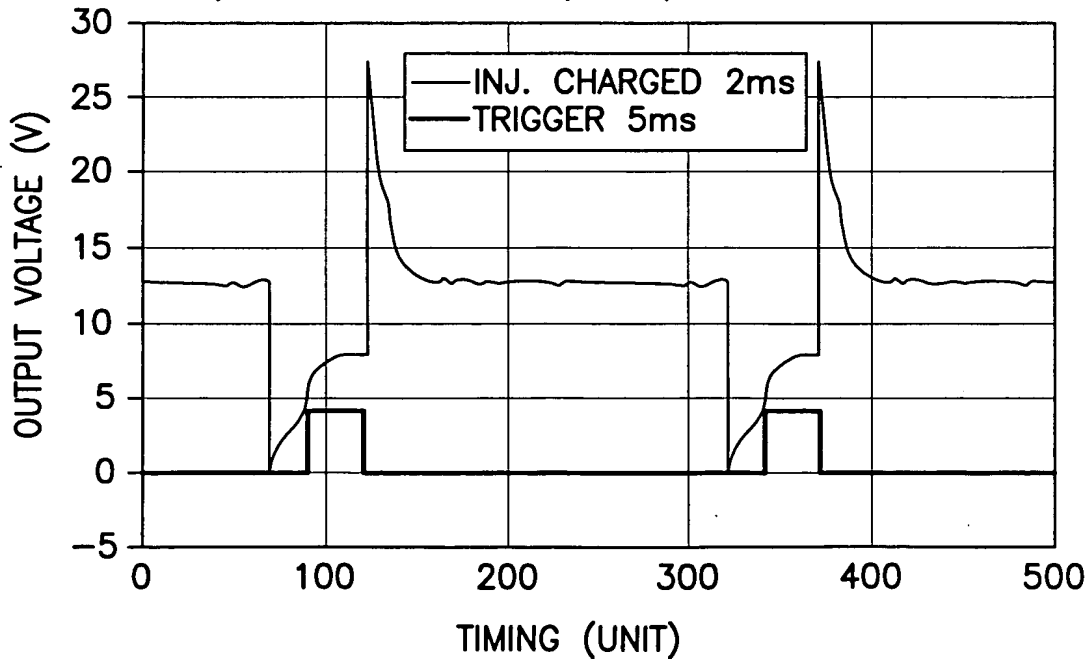


FIG.12B

13/72

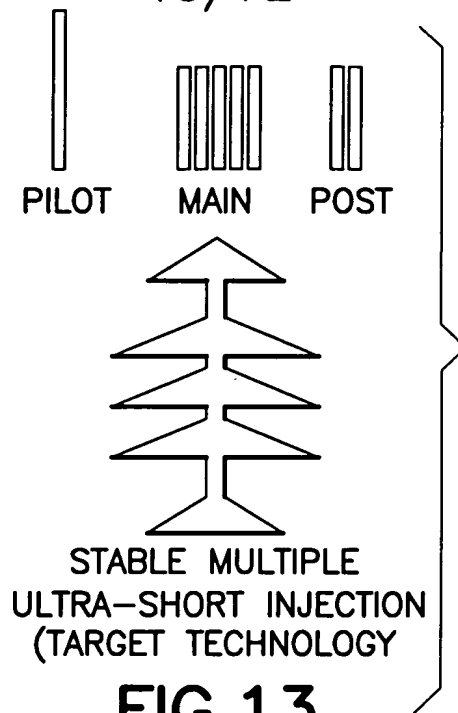


FIG.13

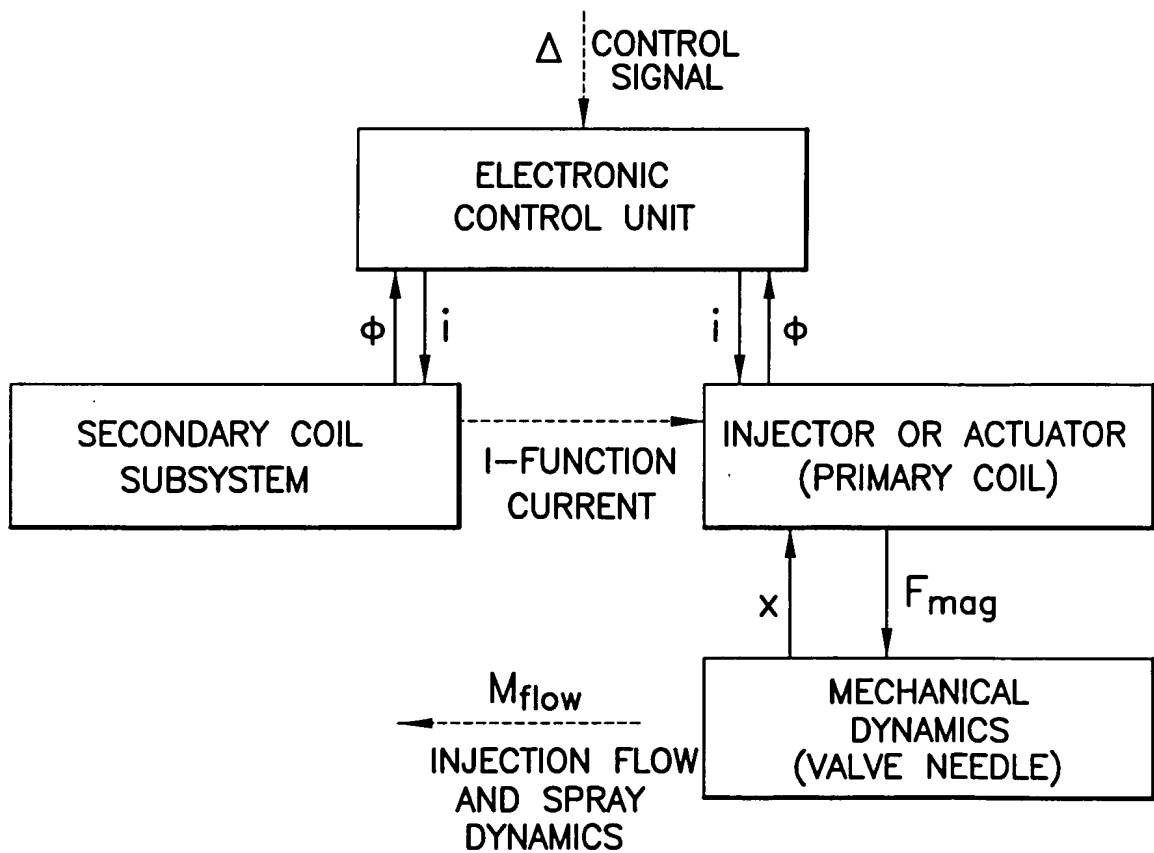


FIG.14

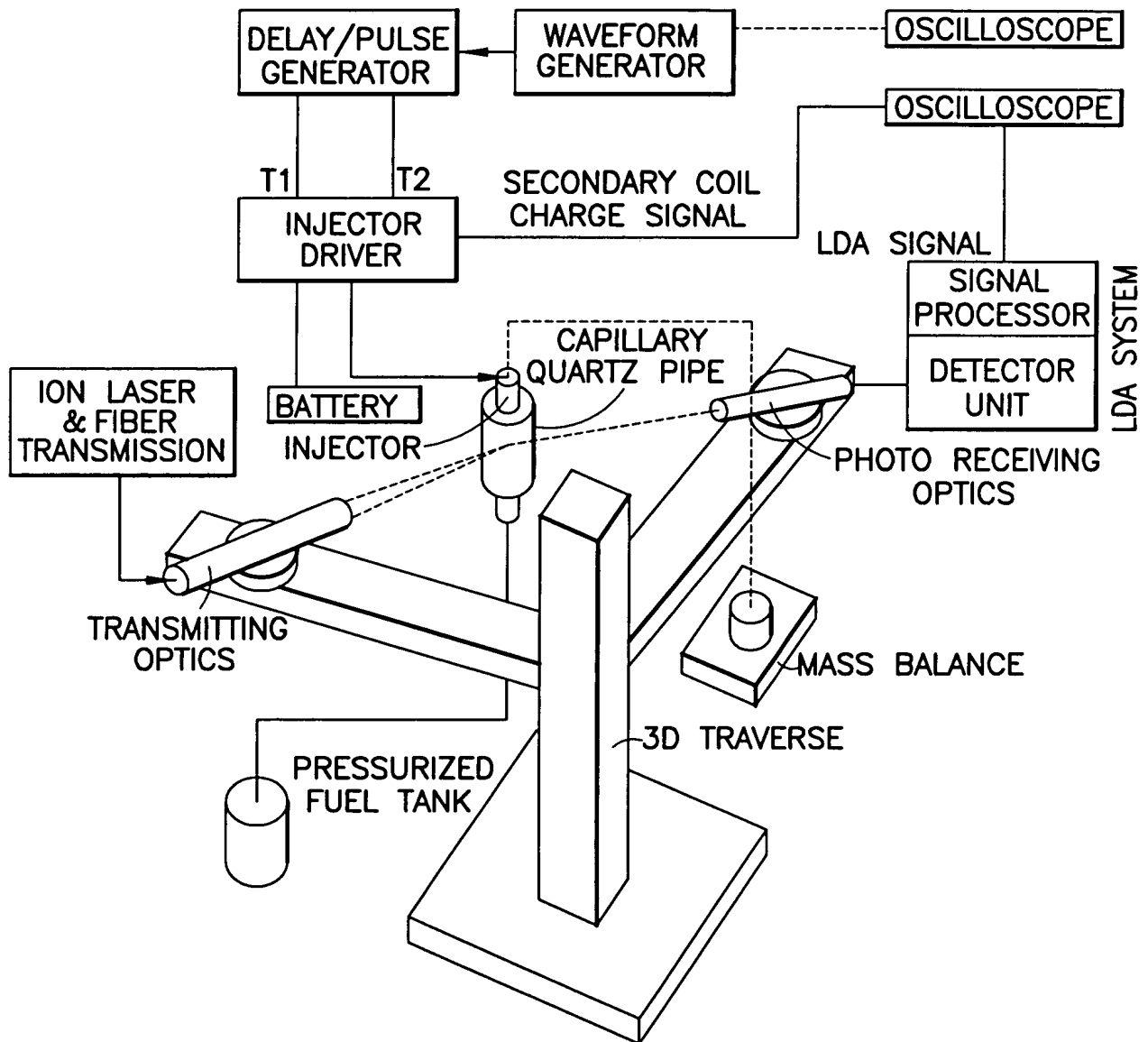


FIG.15

15/72

COMPARISON OF DIFFERENT CHARGING SCENARIOS:
 $P=7.3\text{atm}$, $f=50\text{Hz}$, SC CHARGING 2.0ms

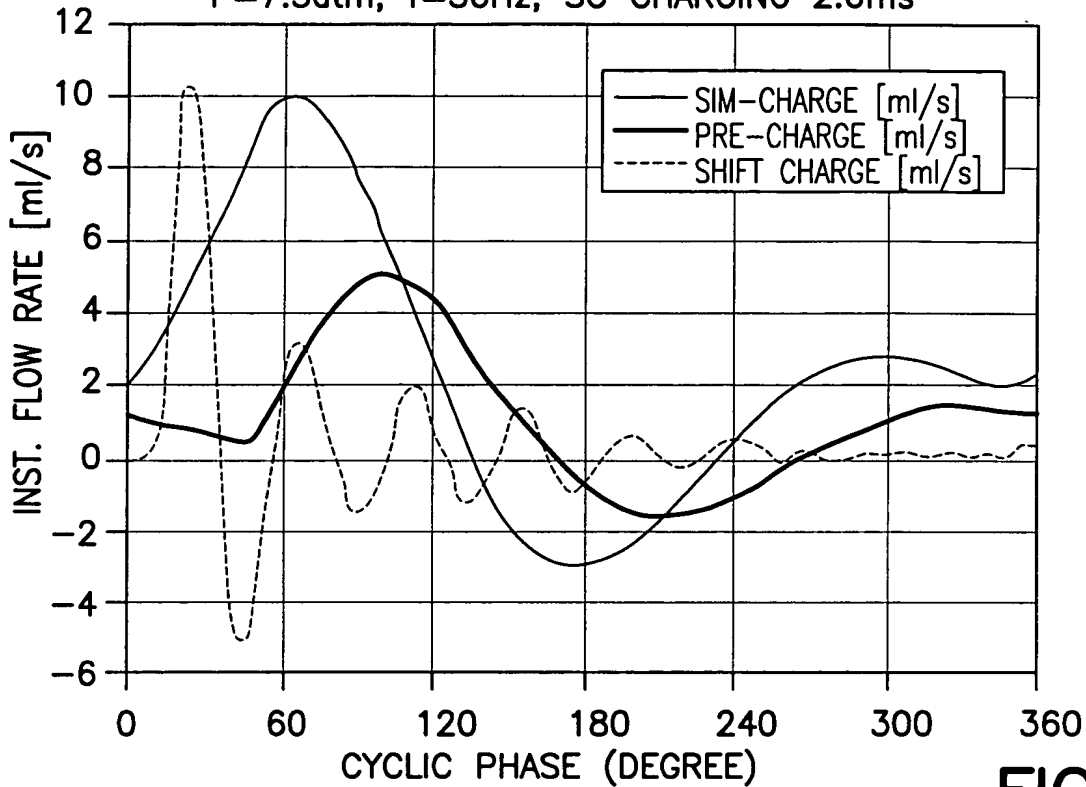


FIG.16A

COMPARISON OF DIFFERENT SC CHARGING SCENARIOS:
 $P=7.3\text{atm}$, $f=50\text{ Hz}$, SC CHARGING 2.0ms, $\tau=3$ & 5ms

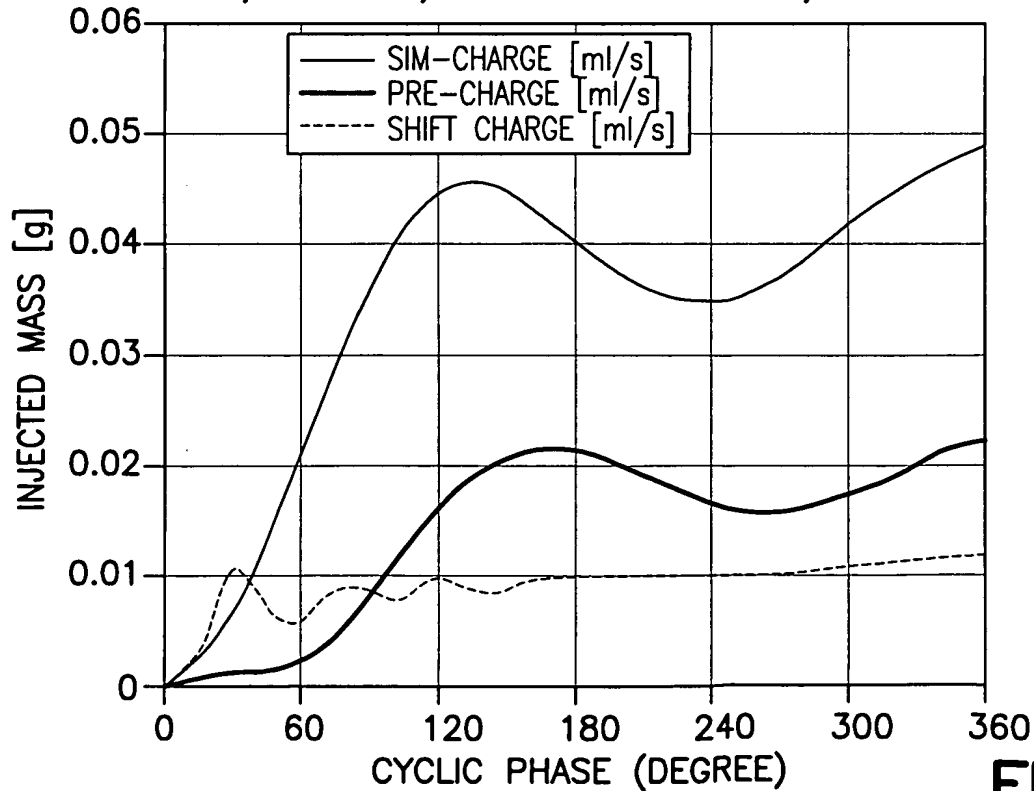


FIG.16B

SIMULTANIOUSLY CHARGED SC: CHARGING 0.0, 1.0, 1.5
AND 2ms $f=50\text{Hz}$, $\tau=5\text{ms}$, $P=7.3\text{atm}$

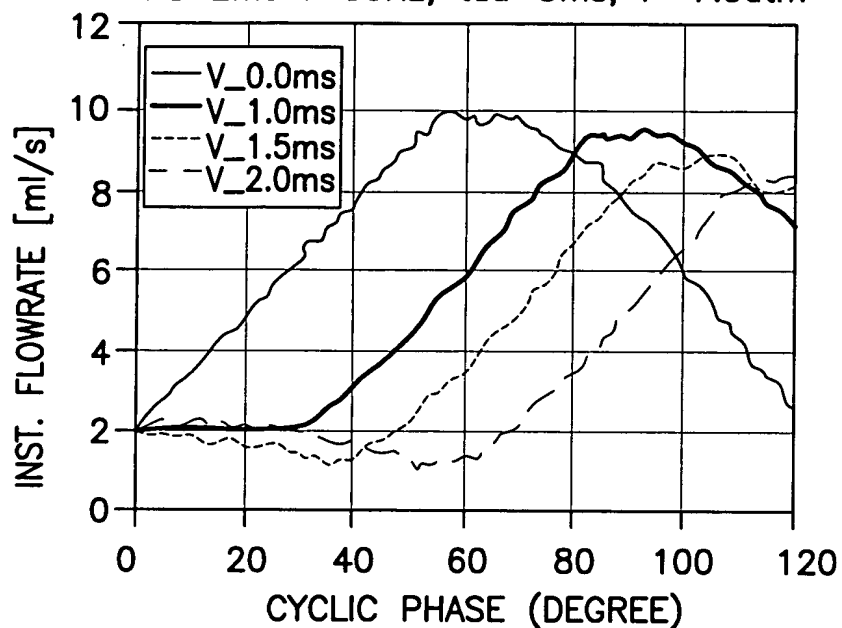


FIG.17A

SIMULTANIOUS CHARGE SC: CHARGING 0.0, 1.0, 1.5
AND 2ms $f=50\text{Hz}$, $\tau=5\text{ms}$, $P=7.3\text{atm}$

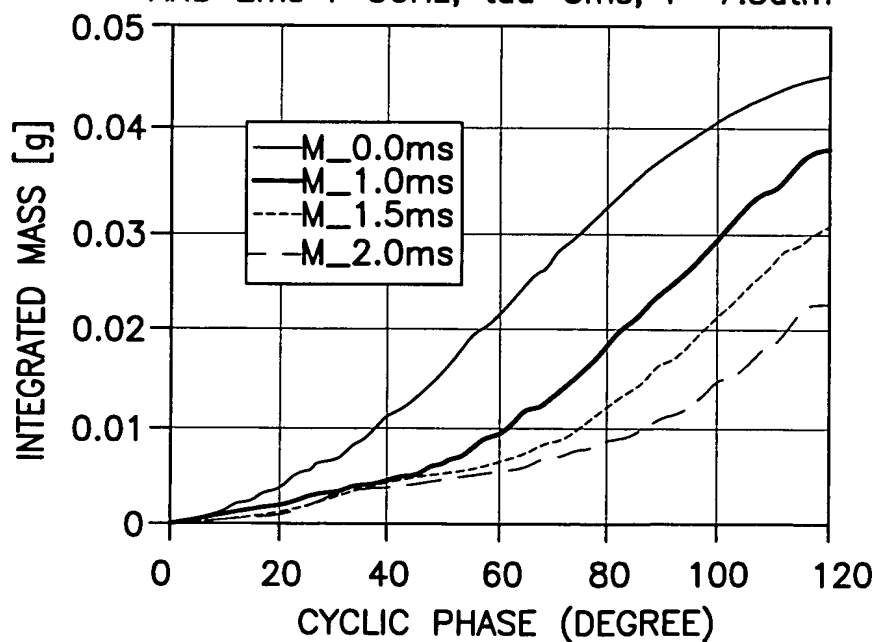


FIG.17B

17/72

PRE-CHARGE SC: CHARGING 0.5, 1.0 AND 1.5ms
 $f=50\text{Hz}$, $\tau=3\text{ms}$, $P=7.3\text{atm}$

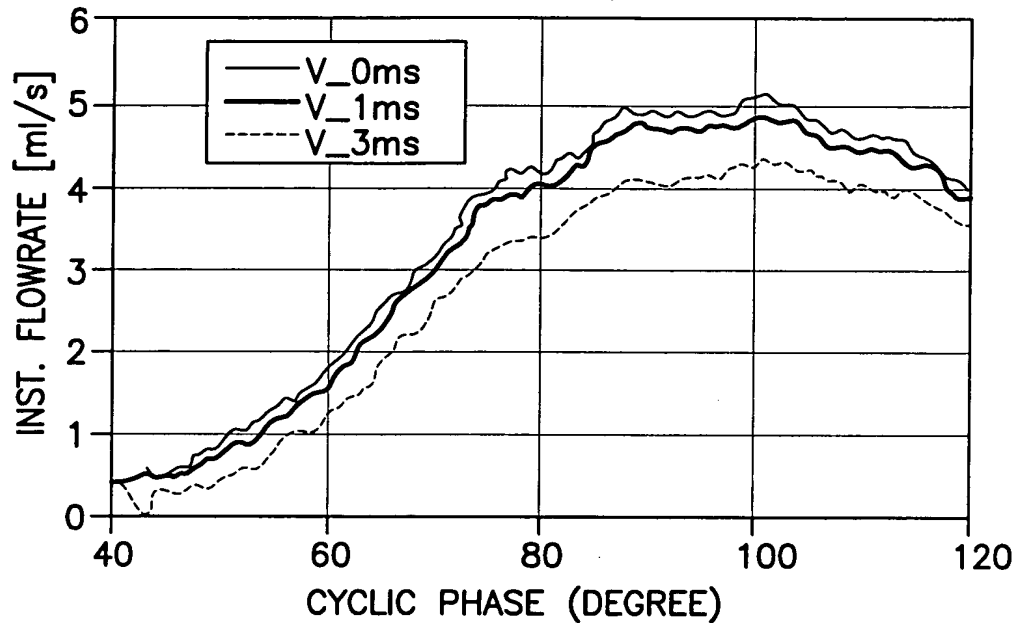


FIG.17C

PRE-CHARGED SC: CHARGING 0.0, 1.5 AND 3.0ms
 $f=50\text{Hz}$, $\tau=3.0\text{ms}$, $P=7.3\text{atm}$

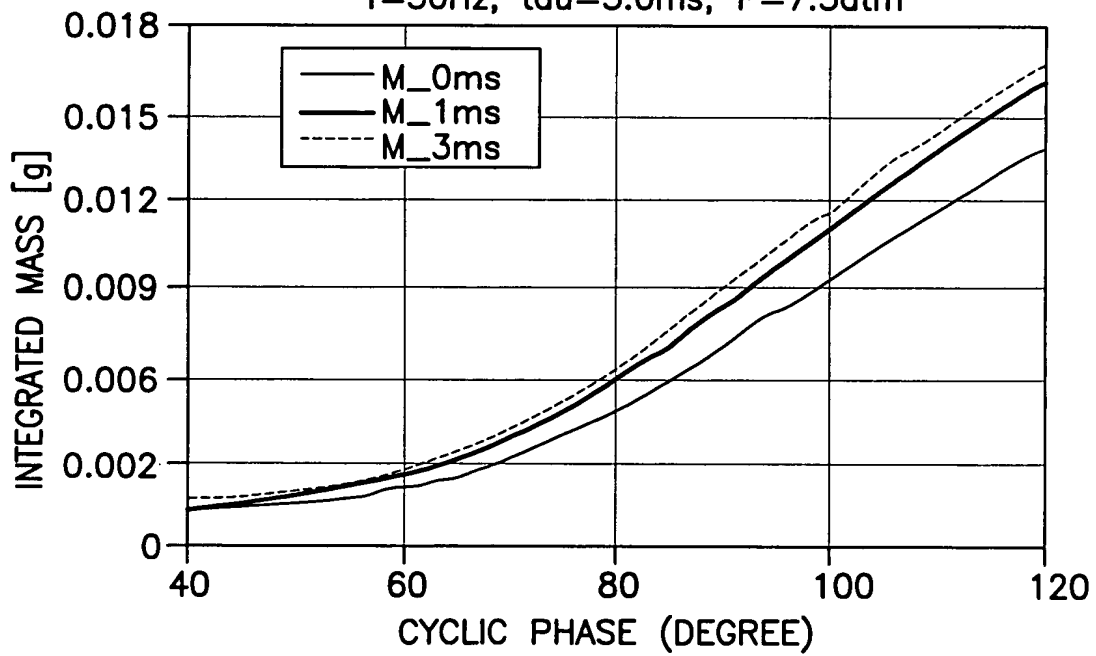


FIG.17D

18/72

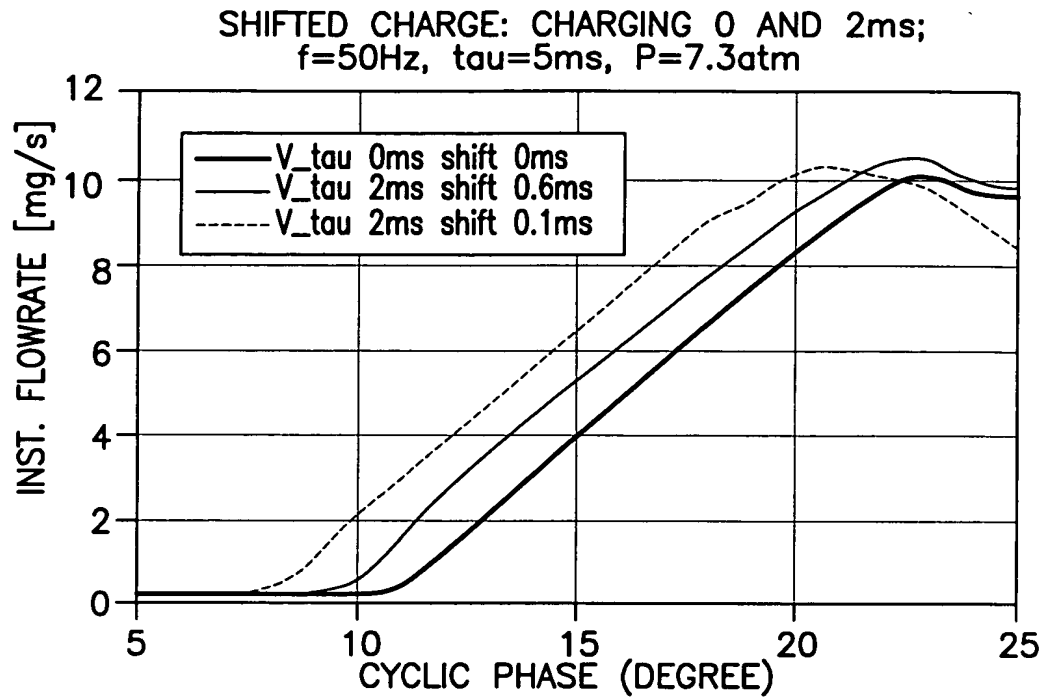


FIG.17E

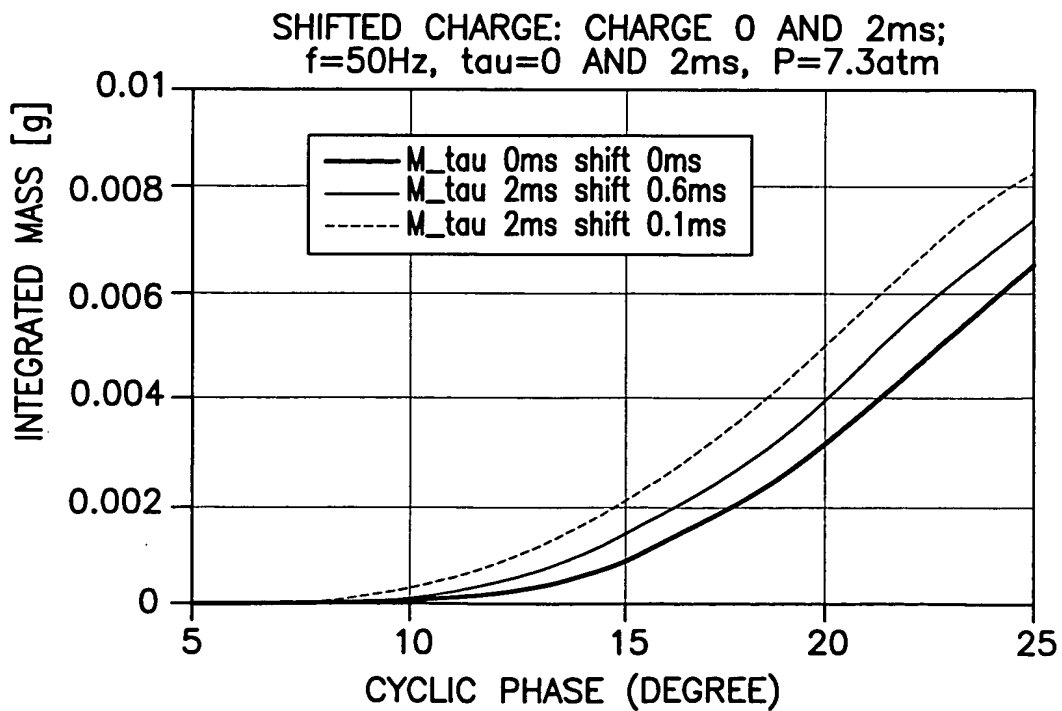


FIG.17F

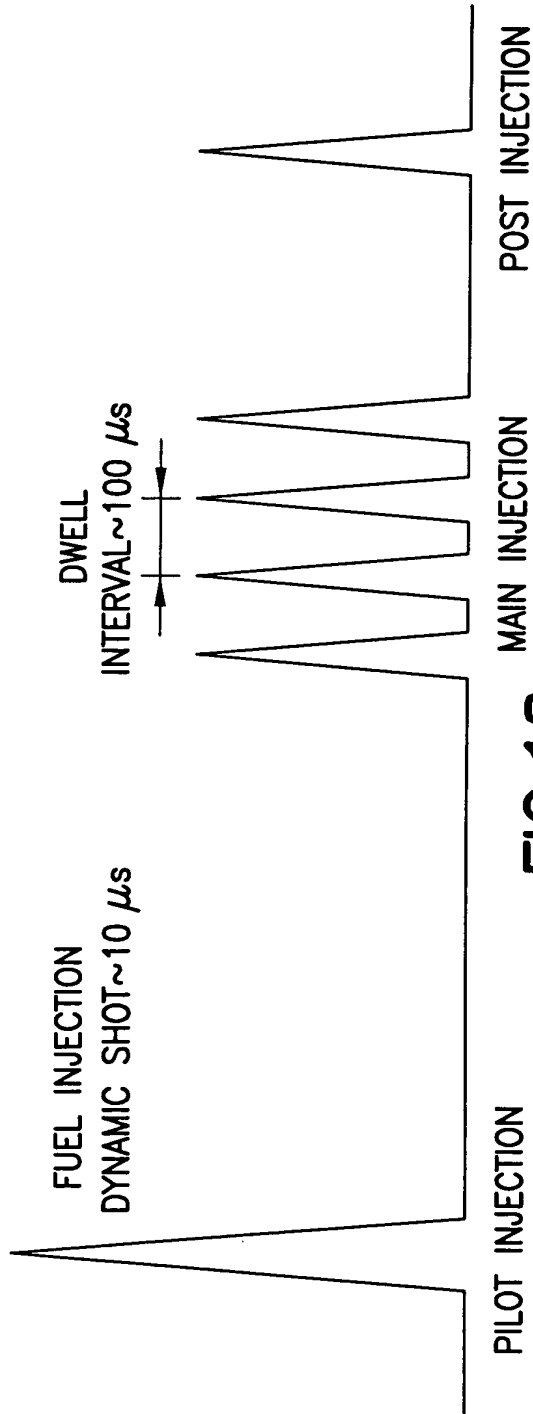


FIG. 18

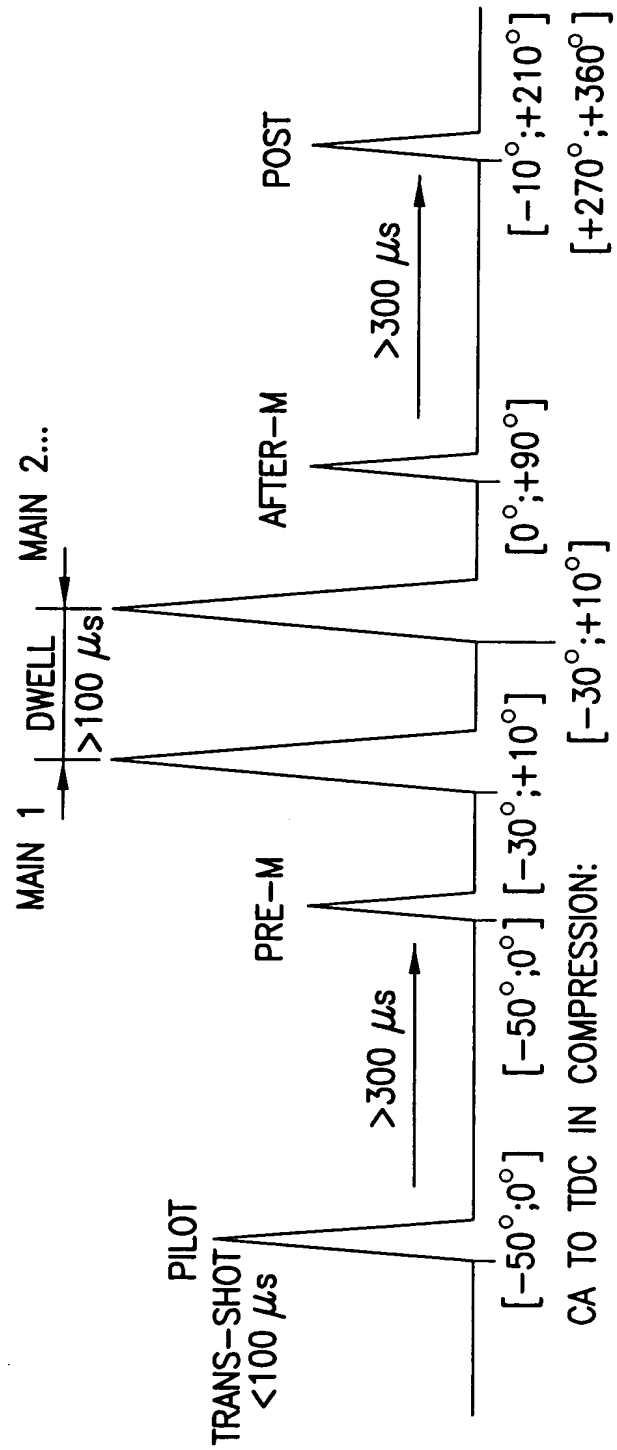


FIG. 19

# INJECTOR	L_{mean} μH max	L_{mean} μH max	R_{mean} Ω min	R_{mean} Ω max	TIME L/R μsec AVERAGED	ω_{21} FREQ kHz	$0.5 \cdot I^2 \cdot L / T$ E_{peak} W L_{p18A}	E_{hold} W L_{h12A}	$4 \cdot E_{peak}$ W	$\omega_{22} =$ $w_{21} / 2$ R / L_{22} kHz	$T_{22} = T_{21} \cdot 2$ $T = R / L_{22}$ μsec	L_{22} μH I_{p18A}	R_{22} Ω $R = L / T$
BOSCH ENGINE													
1 I	65.73	65.75	0.45	0.45	146	6.85	72.9	4.7	291.6	3.42	292	526	1.80
2 II	76.24	76.35	0.35	0.45	191	5.24	64.8	5.5	259.2	2.62	381	610	1.60
3 III	68.48	68.41	0.35	0.45	171	5.84	64.8	4.9	259.2	2.92	342	548	1.60
3 IV	69.42	69.58	0.35	0.45	174	5.76	64.8	5.0	259.2	2.88	348	556	1.60
ADDIT:													
4 V	79.79	79.85	0.35	0.45	200	5.01	64.8	5.7	259.2	2.51	399	639	1.60
5 VI	84.75	84.84	0.35	0.45	212	4.72	64.8	6.1	259.2	2.36	424	678	1.60
6 VII	79.69	79.69	0.35	0.45	199	5.02	64.8	5.7	259.2	2.51	398	638	1.60

FIG.20

21/72

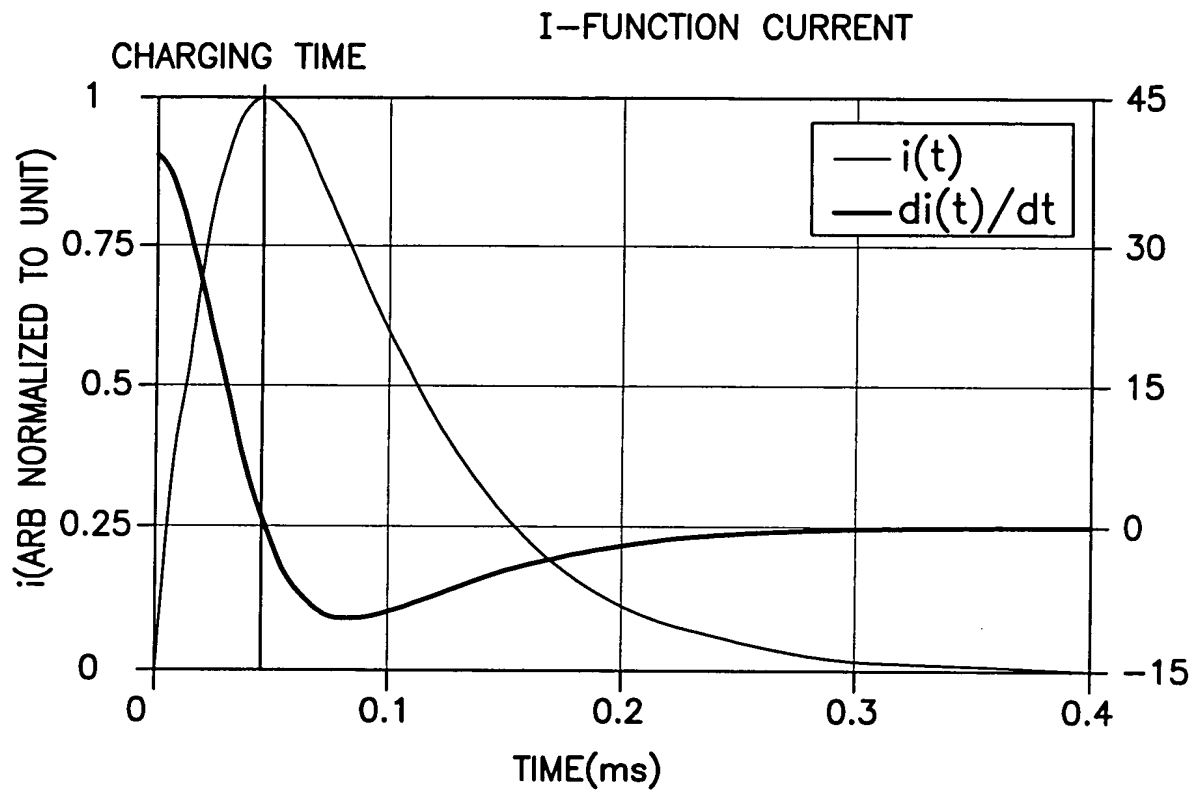


FIG.21

22/72

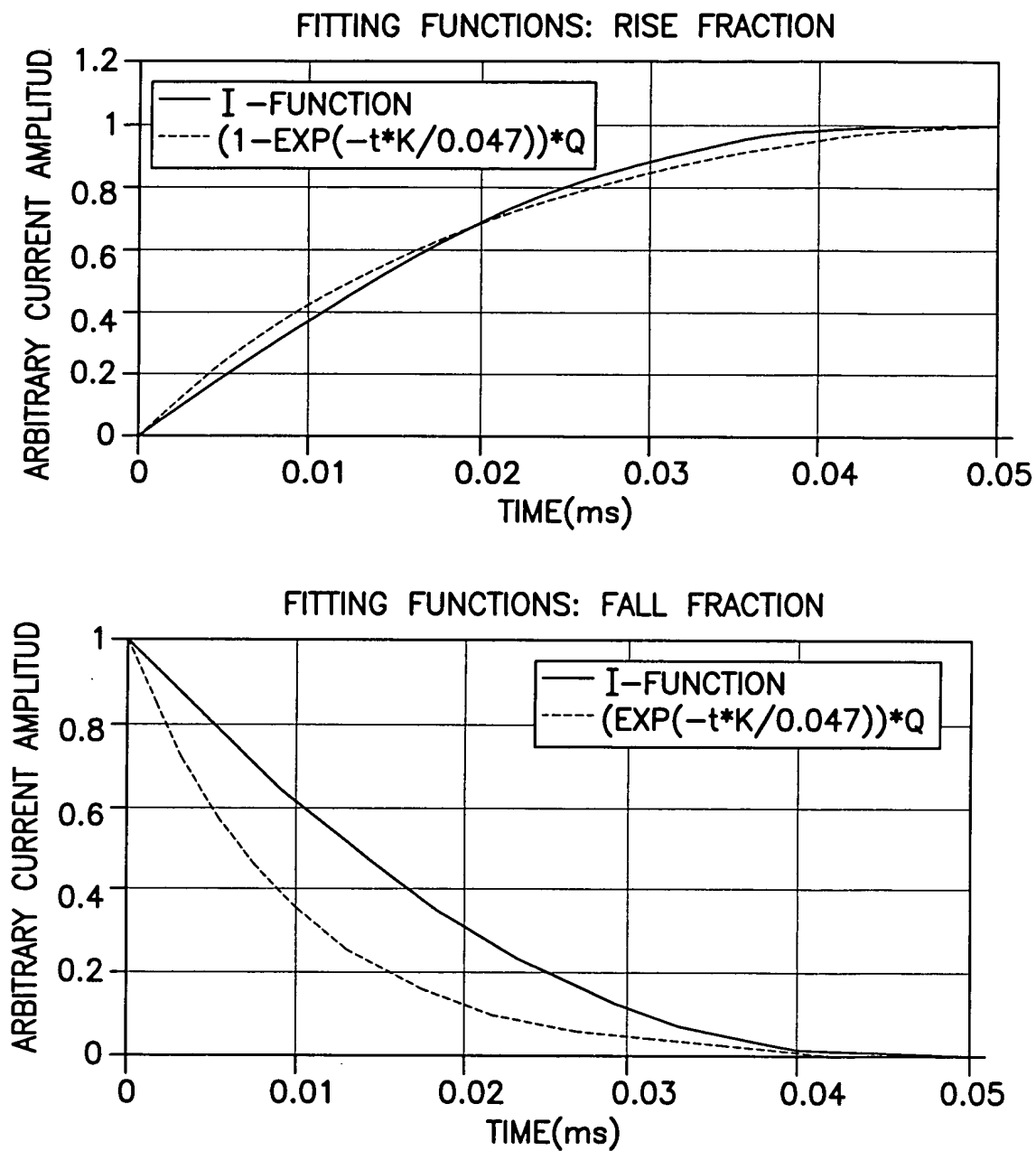


FIG.22

FIG.23A

No.	PARAMETER	CALCUL FORMULA	DIMENSION	VALUE	CONTROL	DEVICE/UNIT
1	INDUCTANCE	L, MEASURED	μH	#REF!	L/R METER IIB	BOSCH INJECTORI
2	RESISTANCE	R, MEASURED	Ω	#REF!	MUTIMETER	BOSCH INJECTORI
3	T-RESPONCE	L/R	μs	#REF!	HP INFINUM SCOPE 500 MHz, 1GSa/s	BOSCH PROFILE
4	F-RESPONCE	R/L	kHz	#REF!	HP INFINUM SCOPE 500 MHz, 1GSa/s	BOSCH PROFILE
5	CYCLE [Hz] 33.33	CONSIDERED	DEGREE ms pts	360 30.0 16000	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM
6	P INJECTION OFFSET "-X deg BTDC"	CONSIDERED START	DEGREE ms pts	157.5 13.13 7000	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM
7	M INJECTION OFFSET "TDC"	CONSIDERED	DEGREE ms pts	180 15.00 8000	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM

8	P_M INTERVAL	P_off - M_off X BTC	DEGREE μ s pts	22.5 1875 1000	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM
9	NORMAL INJECTION "-X deg BTDC"	max 2.2 ms	DEGREE μ s pts	26.4 2200 1173	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM
10	P_DURATION= M_DURATION	CONSIDERED	DEGREE μ s pts	7.2 600 320	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM
11	P_M_dwell	(P_off-M_off)-P_dur	DEGREE μ s pts	15 1275 680	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	SOLENOID INJECTOR PROGRAM
12	TOTAL INJECTION DURATION	P_dur+dwell+M_d_off	DEGREE μ s pts	30 2475 1320	HP/AGILENT 33120A 15 MHz WAVEGENERATOR	INJECTOR SOLENOID PROGRAM

FIG.23B

FIG.23

FIG.23A

FIG.23B

25/29

SCALES	I[A]	2.0	t[ms]	0.200
	L[mm]	9.8	L[mm]	14.1
	I/L[A/mm]	0.204t/L[ms/mm]		0.01418

FIRST SHOT [us]	600	POINTS	320
SECOND SHOT [us]	600	POINTS	320
DWELL INTERVAL [us]	1275	POINTS	680

PROFILE MI_33_2x600_1275_SC	PHASE	τ_{lin} [mm]	I _{lin} [mm]	τ_{abs} [ms]
τ_{off} [pts] 7000 157.5° FIRST SHOT	A	0.0	0.0	0.000
	B	I-FUNCTION	FIRST PEACK	0.175
	C	3.6	56.2	0.051
	D	CALCULATION	56.0	0.280
	E	I-FUNCTION	0.0	0.094
	CD_osc	4.5	TOTAL	0.600
			2.8	0.128
τ_{off} [pts] 8000 180° SECOND SHOT	A	0.0	0.0	0.000
	B	I-FUNCTION	FIRST PEACK	0.175
	C	3.6	56.2	0.051
	D	CALCULATION	56.0	0.280
	E	I-FUNCTION	0.0	0.094
	CD_osc	4.5	2.8	0.128

FIG.24A

26/72

T[pts] 16000
V_arb[-] 1
R[Ohm] 0.45
T[ms] 30.0

FIG.24A FIG.24B

FIG.24

TOTAL pts 320 NUMBER OF SINE CYCLE 5
exp_rise 9.36
exp_fall 9.60

I_abs[A]	pts[-]	I_arb[-]	V_abs[V]	$\Delta T_{pts}[-]$	$\Delta I_{arb}[-]$	$\Delta V_{abs}[V]$
0.00	7000	0.000	0.000	0	0.000	0.000
17.80	7093	1.000	8.010	93	1.000	8.010
11.46	7121	0.644	5.159	27	-0.356	-2.851
11.42	7270	0.642	5.141	149	-0.002	-0.018
0.00	7320	0.000	0.000	50	-0.642	-5.141
0.57	61	0.032	0.257	TOTAL 320		
0.00	8000	0.000	0.000	0	0.000	0.000
17.80	8093	1.000	8.010	93	1.000	8.010
11.46	8121	0.644	5.159	27	-0.356	-2.851
11.42	8270	0.642	5.141	149	-0.002	-0.018
0.00	8320	0.000	0.000	50	-0.642	-5.141
0.57	61	0.032	0.257	TOTAL 320		

FIG.24B

27/72

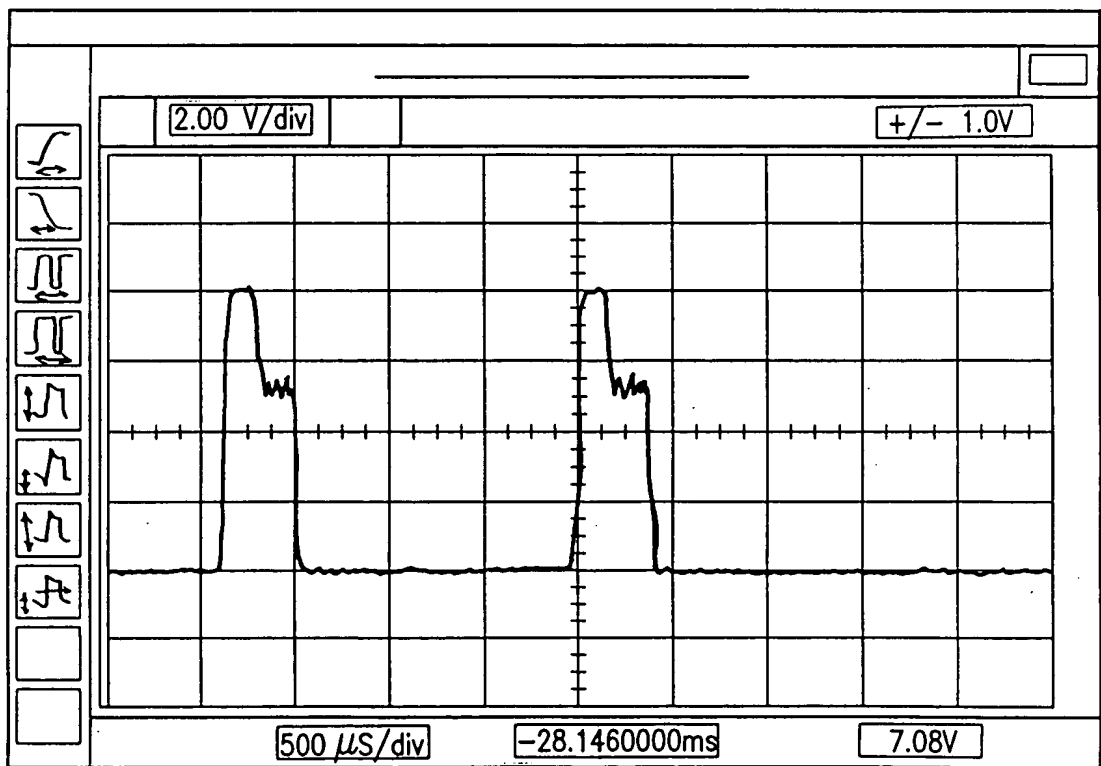
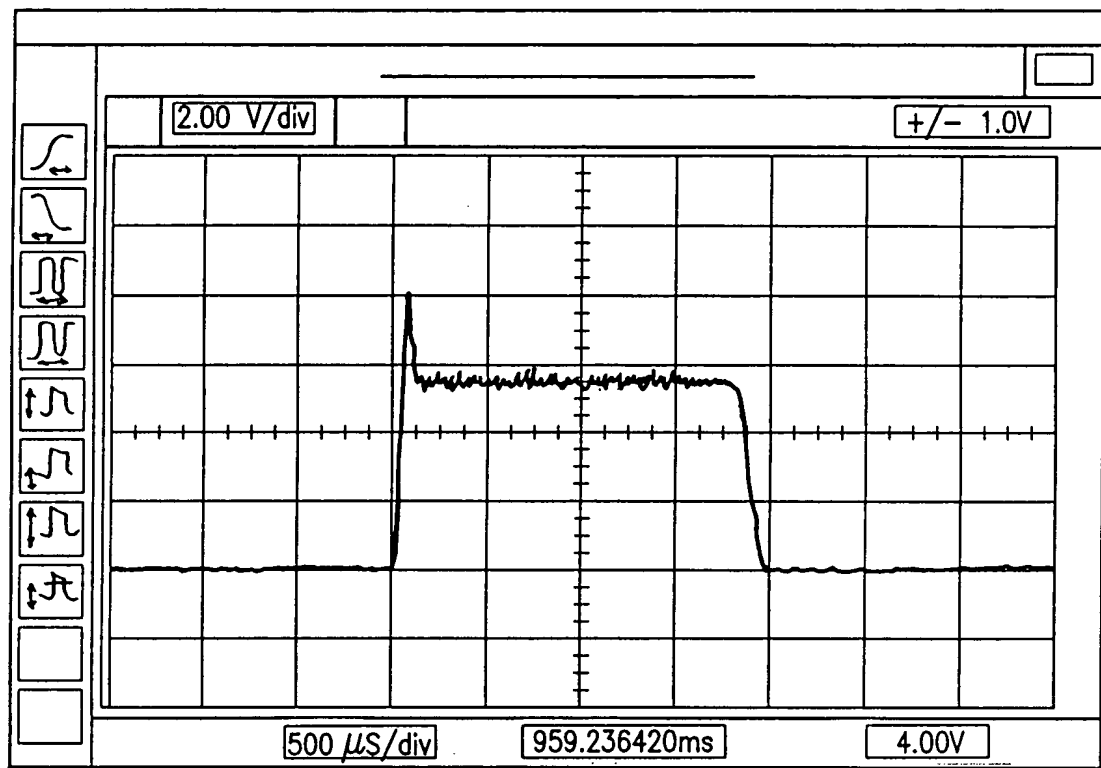


FIG.25

28/72

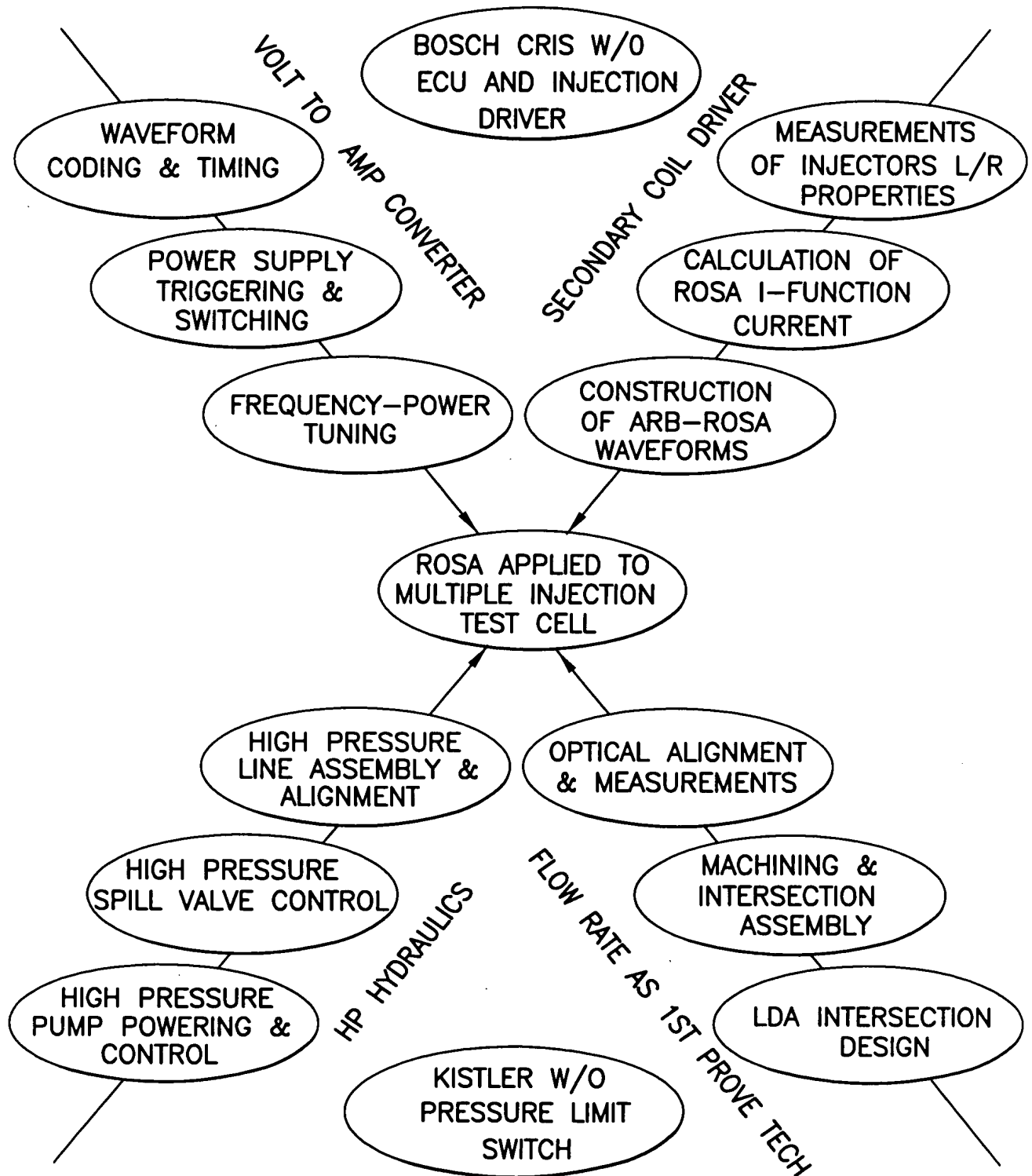


FIG.26

29/72

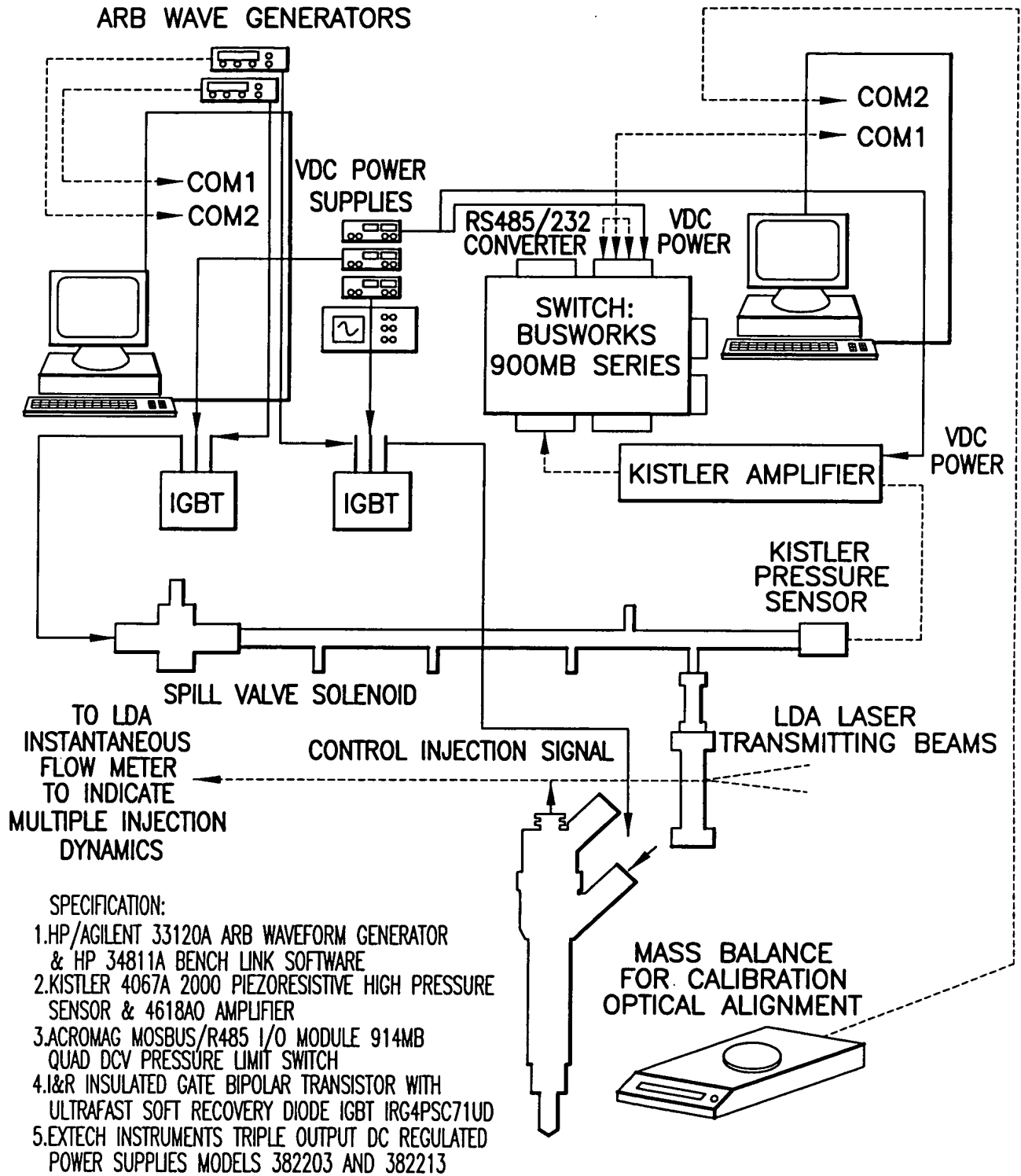


FIG.27

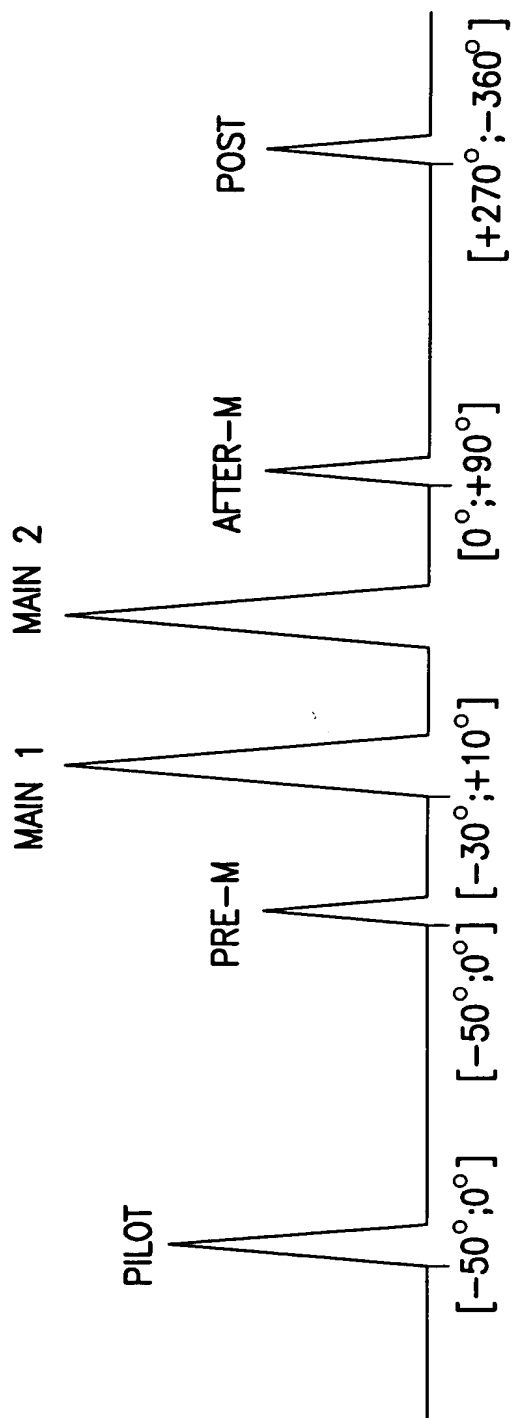


FIG.28

31/72

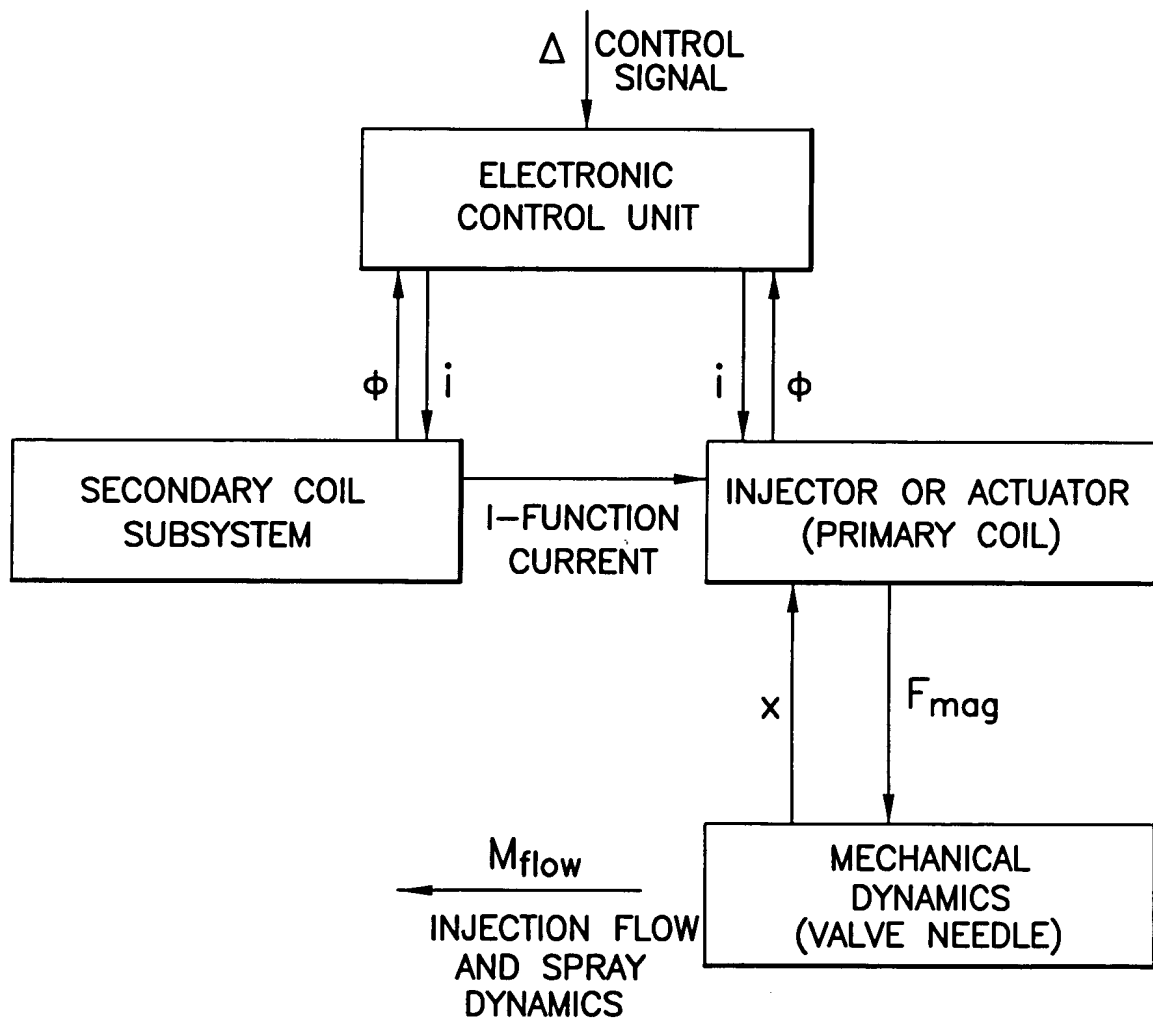


FIG.29

32/72

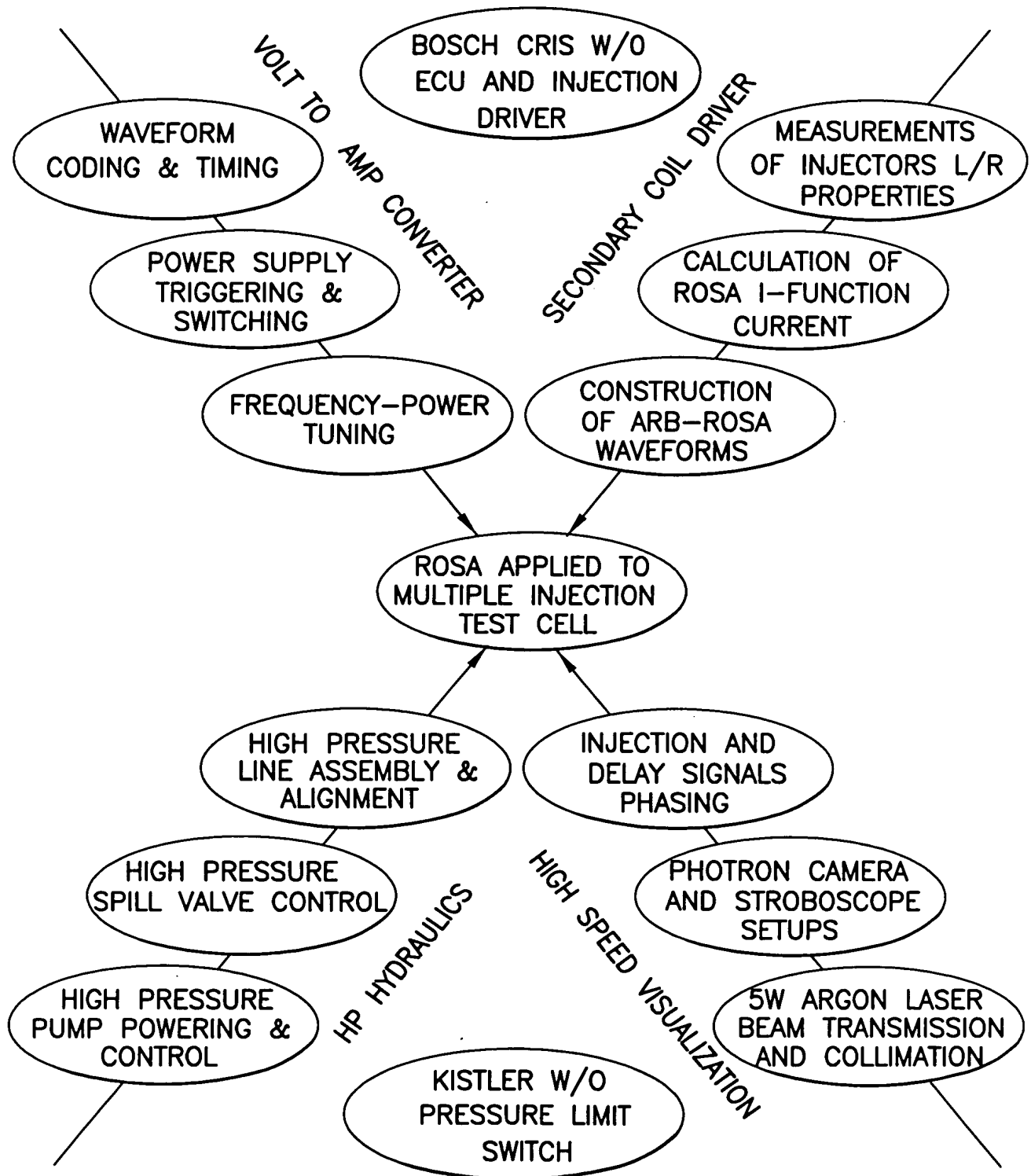


FIG.30

33/72

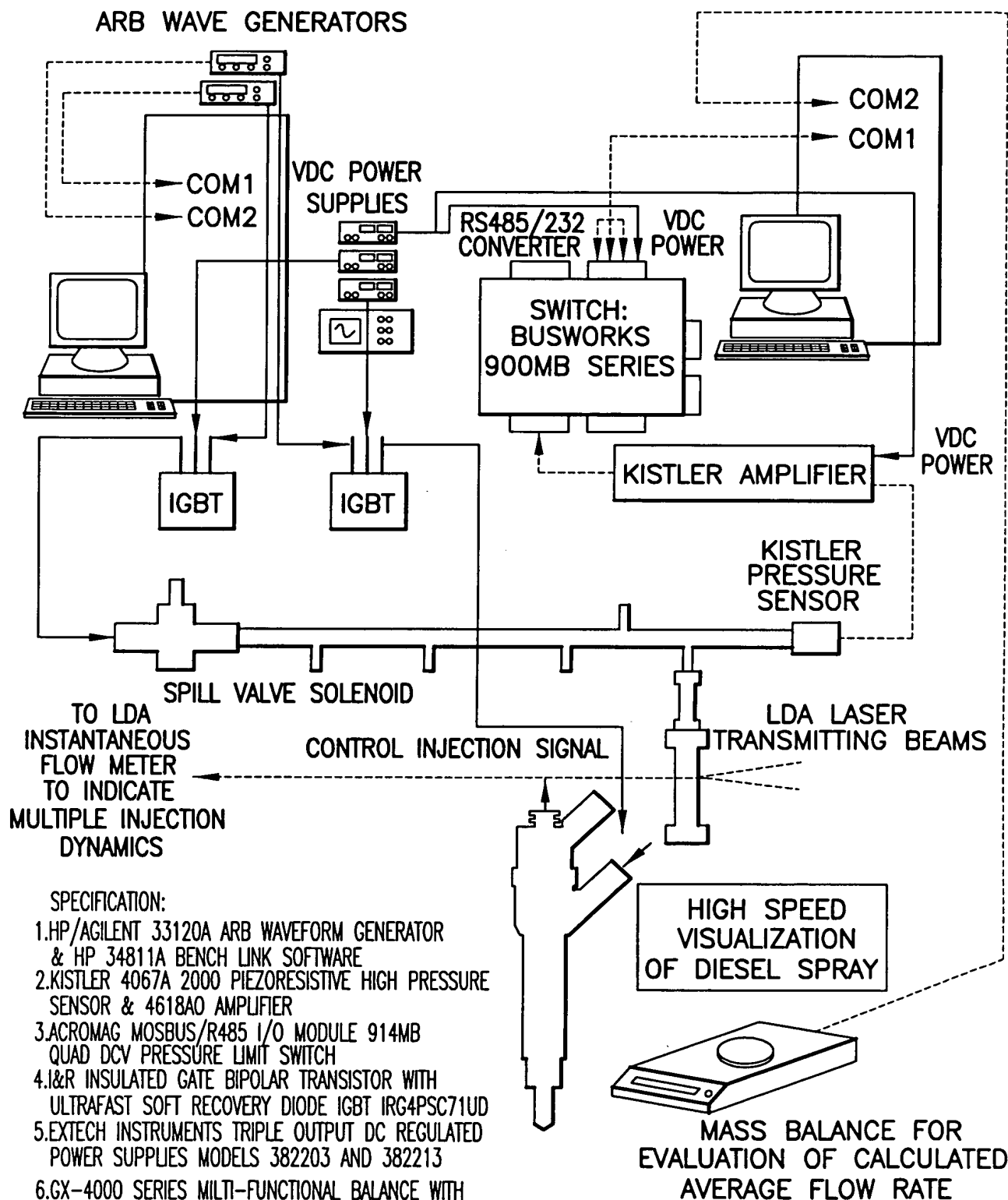


FIG.31

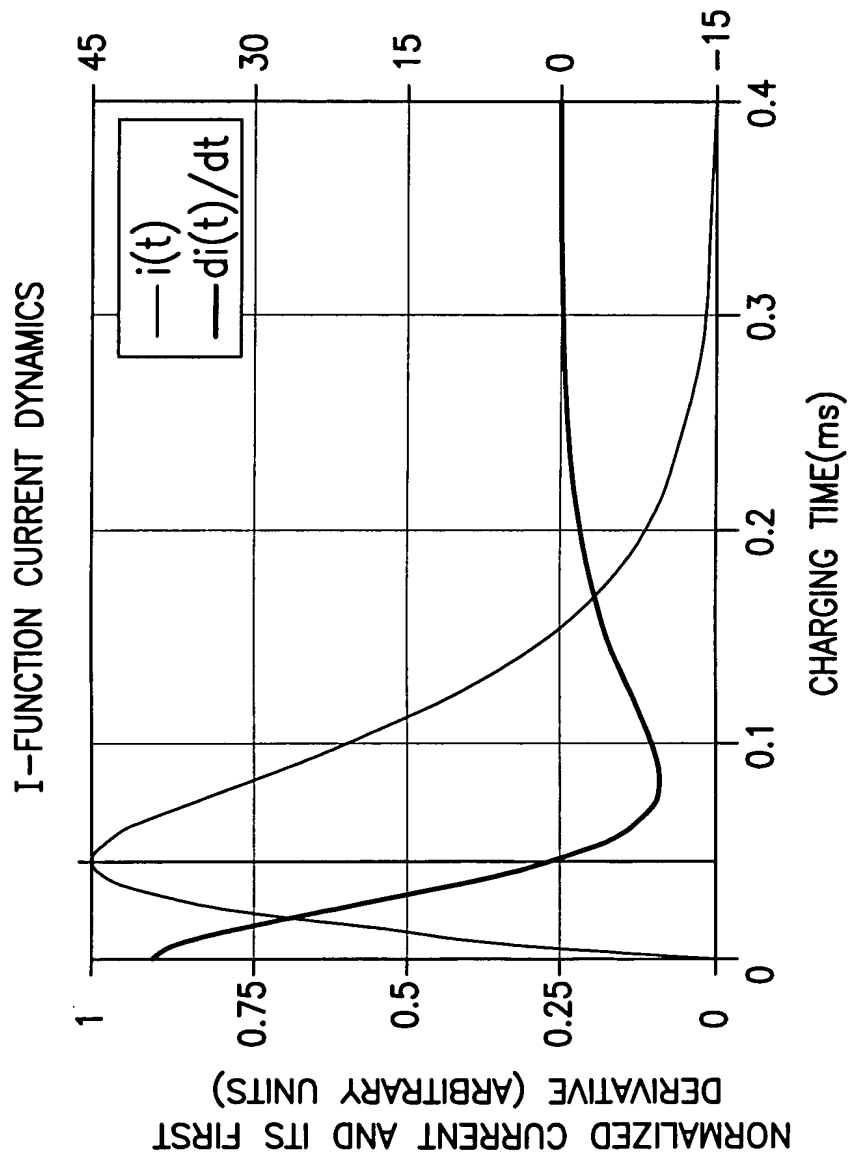


FIG.32

35/72

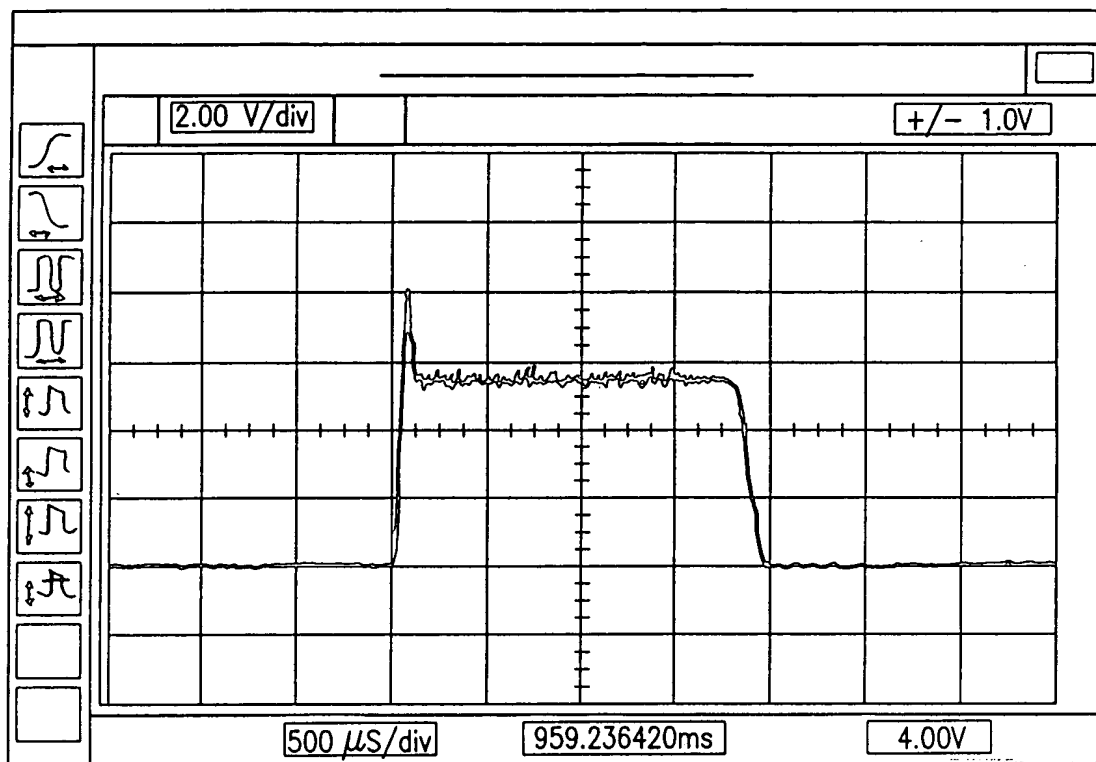


FIG.33

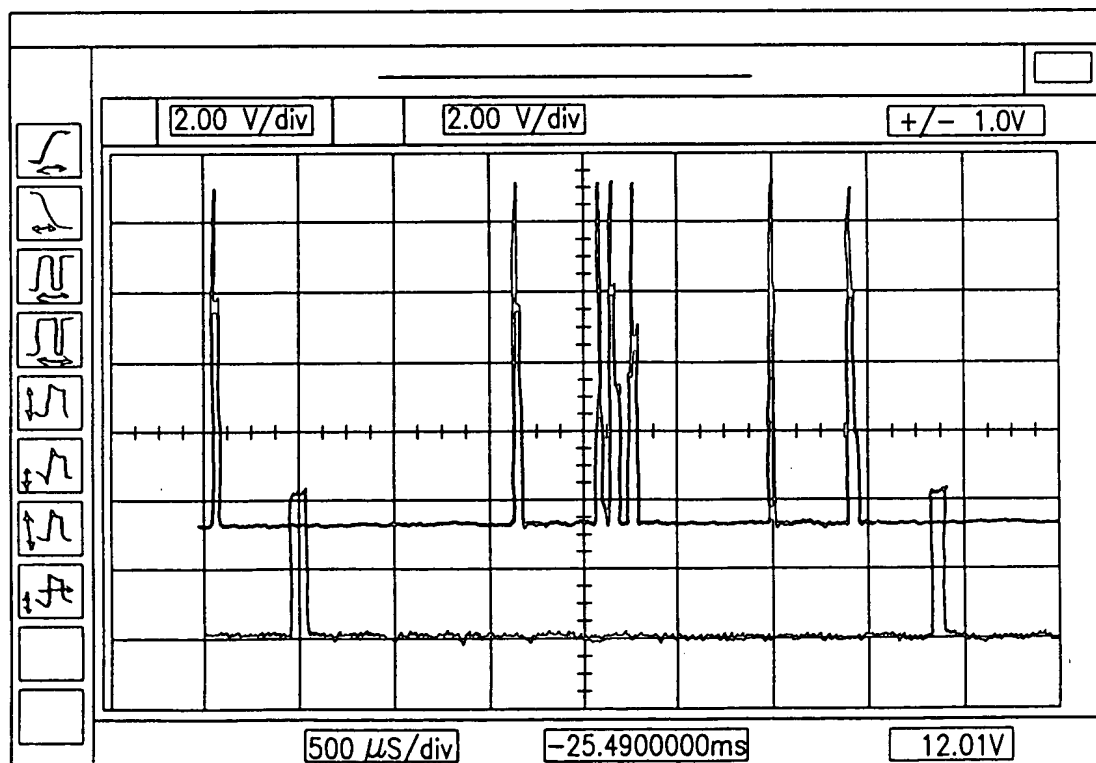


FIG.34

36/72

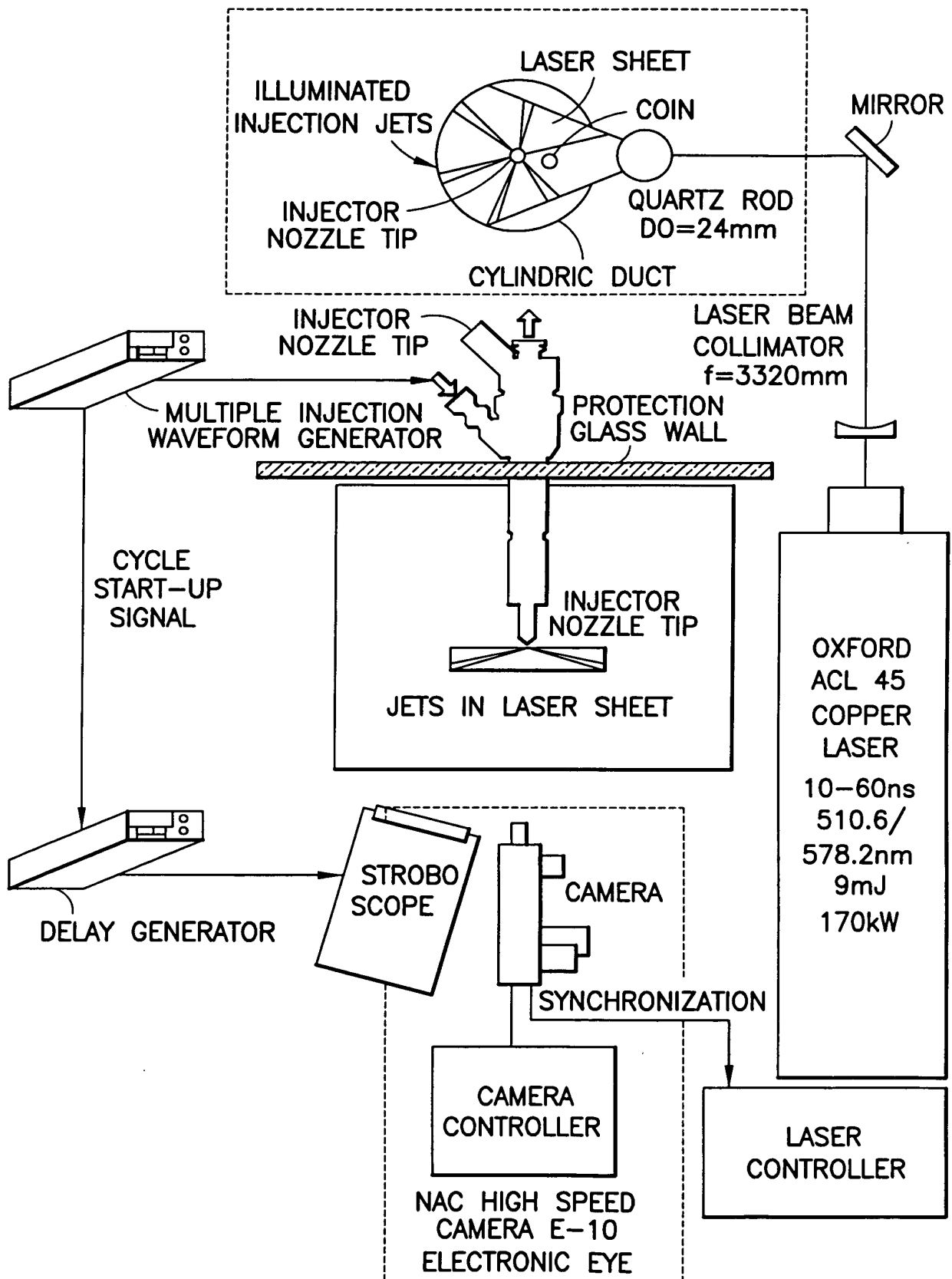
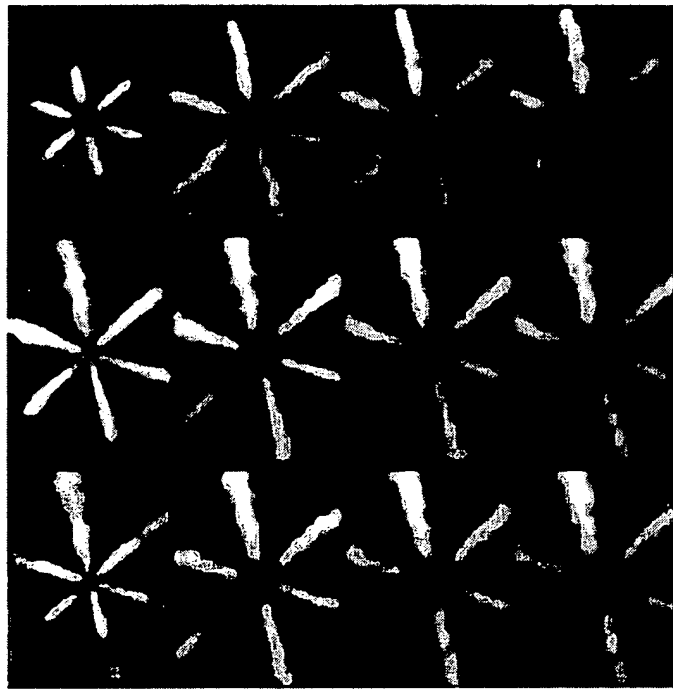


FIG.35

37/72



EXAMPLE OF SPRAY
AT LOW CAMERA SPEED

FIG.36

38/72

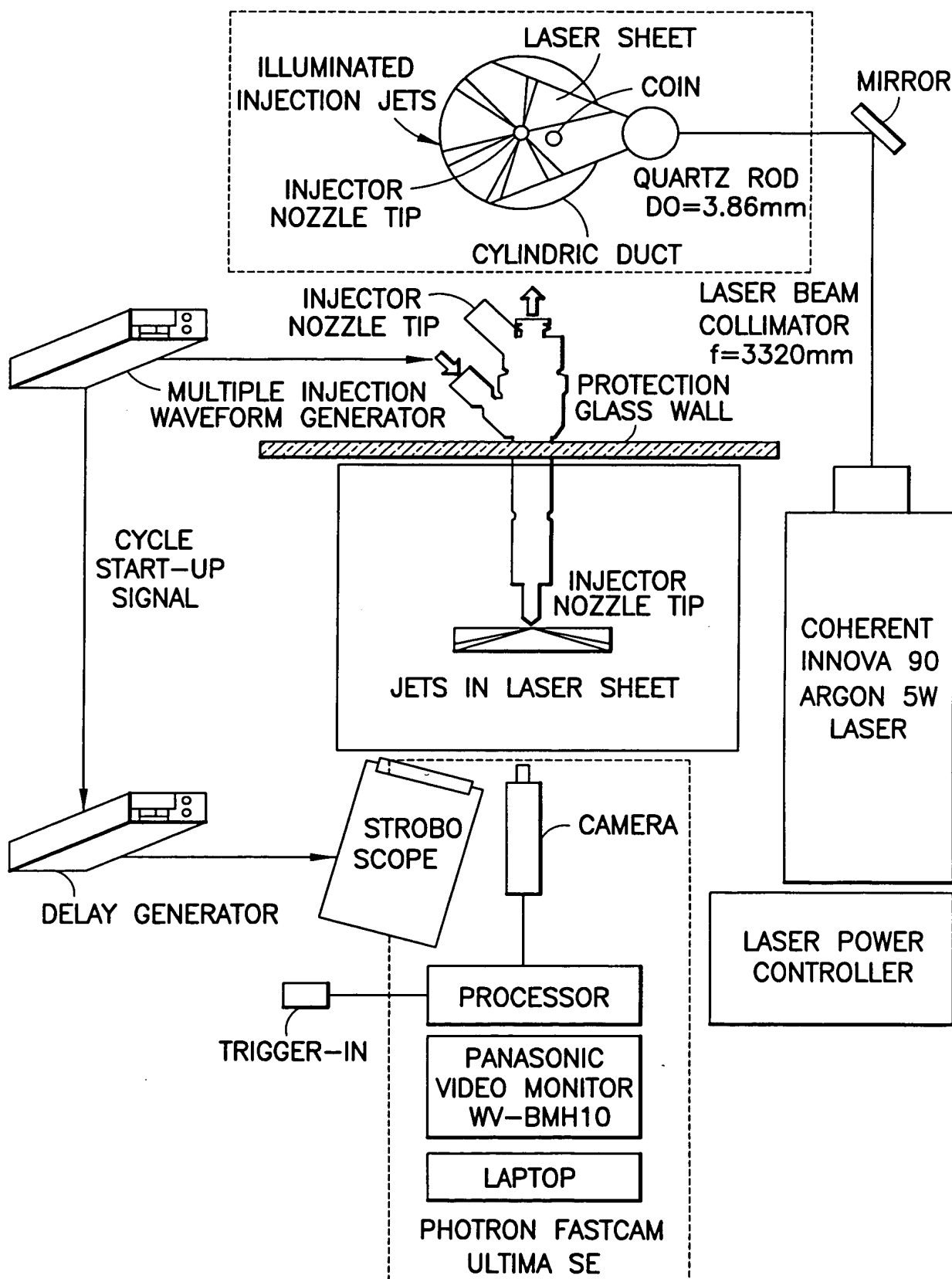
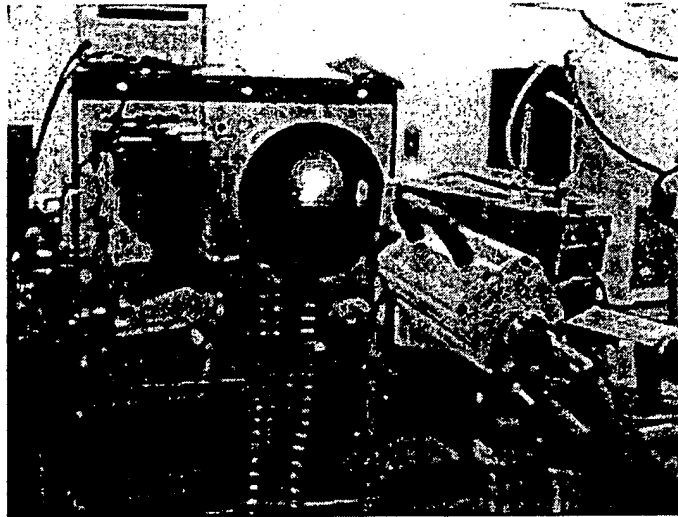
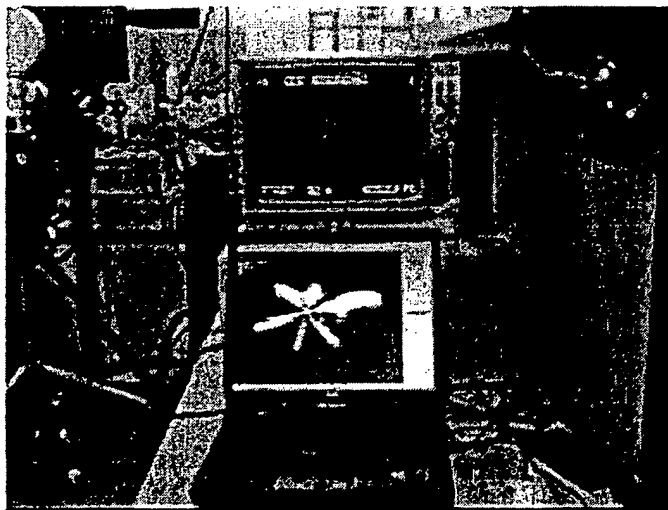


FIG.37

39/72



A. INJECTOR SETUP WITH STROBOSCOPE



B. SIGNAL PROCESSOR WITH MONITOR

FIG.38

VISUALIZATION SPEEDS OF 9,000; 18,000;
27,000 AND 40,500 fps



t=0126166 s



t=0126222 s



t=0126277 s



t=0126333 s



t=0126388 s

VISUALIZATION OPTICS SETUP
WHITE DISC IS US QUARTER

CURRENT TIME
+00:DD:00 126999
FILE INFOR.
FASTCAM--ultimaSE
18000 fps
1 FRAME SEC
256x64
TG START
2719 FRAMES



t=0126333 s

PILOT SHOT IN SIX-SHOT INJECTION: ENGINE SPEED 2,400 RPM,
FRAME DURATION 55.56 μ s, COIN SIZE 24.76 mm.

FIG.39

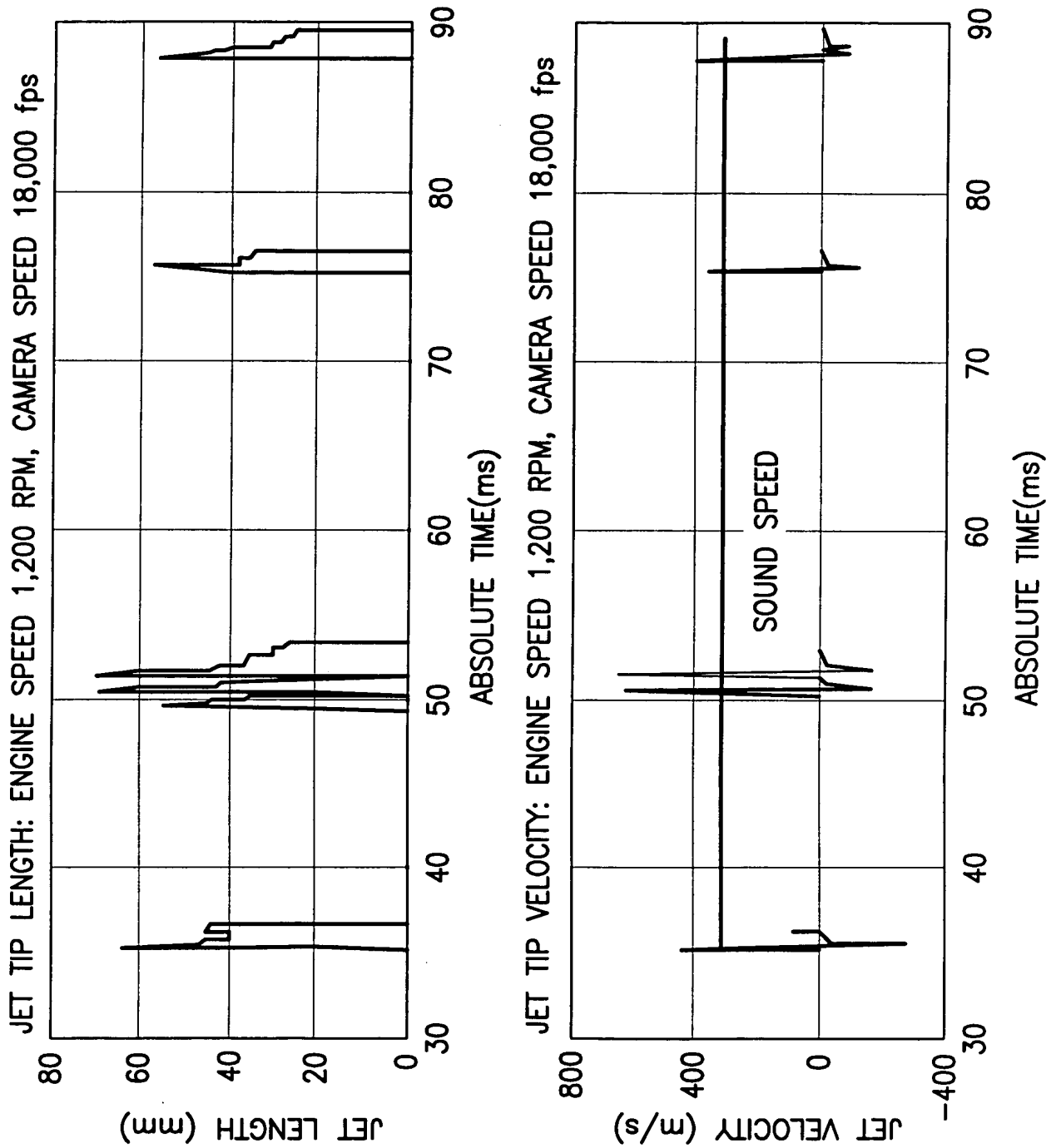


FIG.40

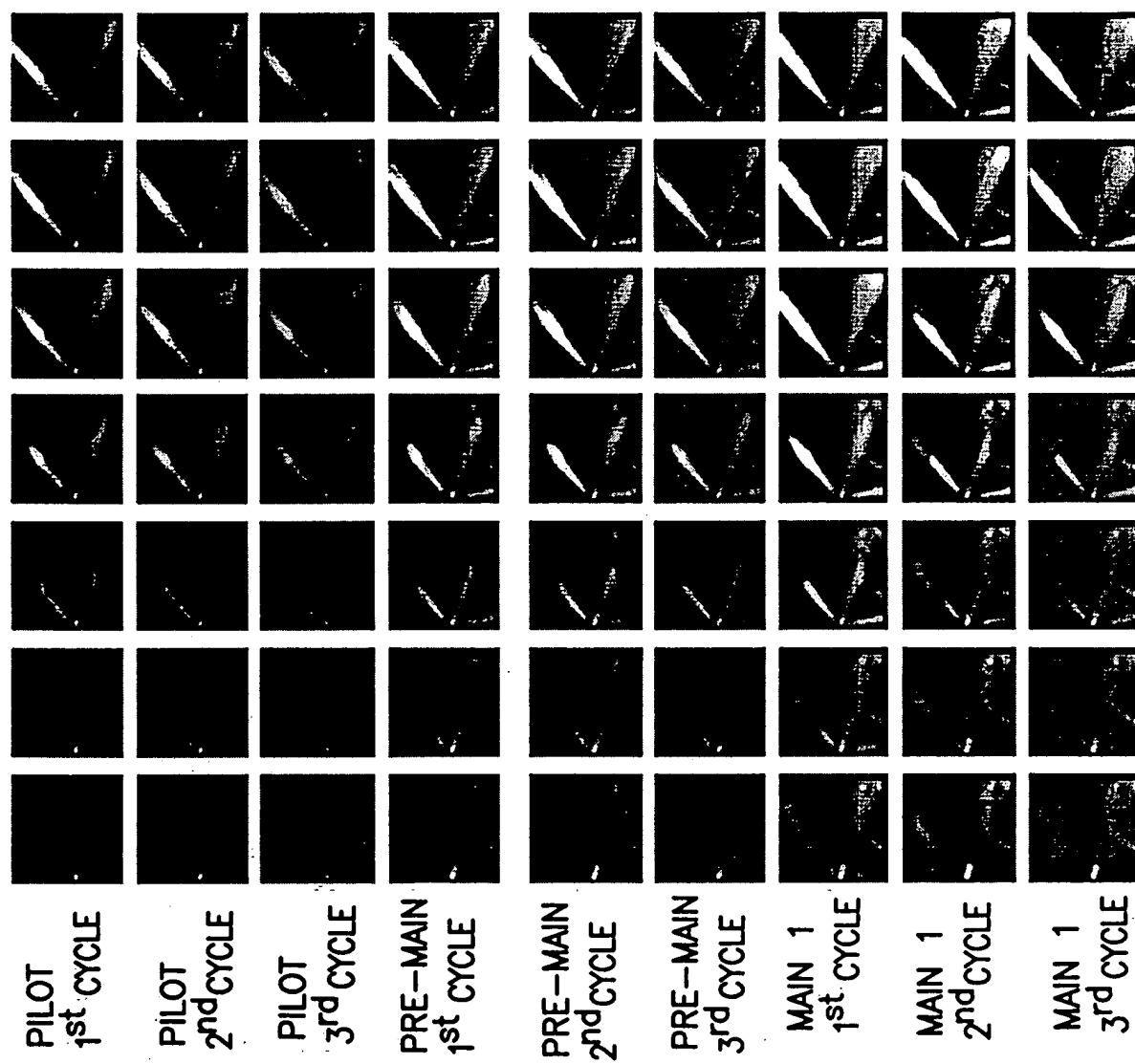


FIG. 41

WAVEFORM ELECTRONIC SETUP, ENGINE SPEED 3,600 RPM										HIGH SPEED CAMERA RECORD AT SPEED OF 40,500 FPS									
DURATION				PHASES				DURATION				PHASES				DURATION			
PTS	MS	DEG		PTS	MS	DEG		FRAMES	MS	DEG		FRAME	MS	DEG		FRAMES	MS	DEG	
PERIOD	16000	33.3	360	PERIOD	16000	33.3	360	1350	33.333	360	PERIOD	1350	33.333	360		1350	33.333	360	
3 Main	288	0.6	6.5	8000	16.667	180		11	0.272	2.9		1969	17.210	185.9					
dwel1_1	96	0.2	2.2	7712	16.067	173.5		21	0.518	5.6									
2 Pre_M	192	0.4	4.3	5600	11.667	126.0		8	0.198	2.1		1940	16.494	178.1					
1 Pilot	192	0.4	4.3	8528	17.767	191.9		8	0.198	2.1		1762	12.099	130.7					
dwel2_2	240	0.5	5.4	12000	25.000	270.0		28	0.691	7.5		2008	18.173	196.3					
4 Main_2	240	0.5	5.4	14000	29.167	315.0		14	0.346	3.7		2302	25.432	274.7					
5 After_M	192	0.4	4.3					9	0.222	2.4		2472	29.630	320.0					
6 Post	192	0.4	4.3					7	0.173	1.9									
Pilot-to-Pre_M										Pilot-to-Pre_M									
Pre_M-to-Main1										Pre_M-to-Main1									
Main1-to-Main2										Main1-to-Main2									
Main2-to-AfterM										Main2-to-AfterM									
AfterM-to-Post										AfterM-to-Post									
				1920	4.000	43.2						170	4.198	45					
				96	0.200	2.16						21	0.519	6					
				240	0.500	5						28	0.691	7					
				3232	6.733	73						280	6.914	75					
				1808	3.767	41						161	3.975	43					

FIG.42

44/72

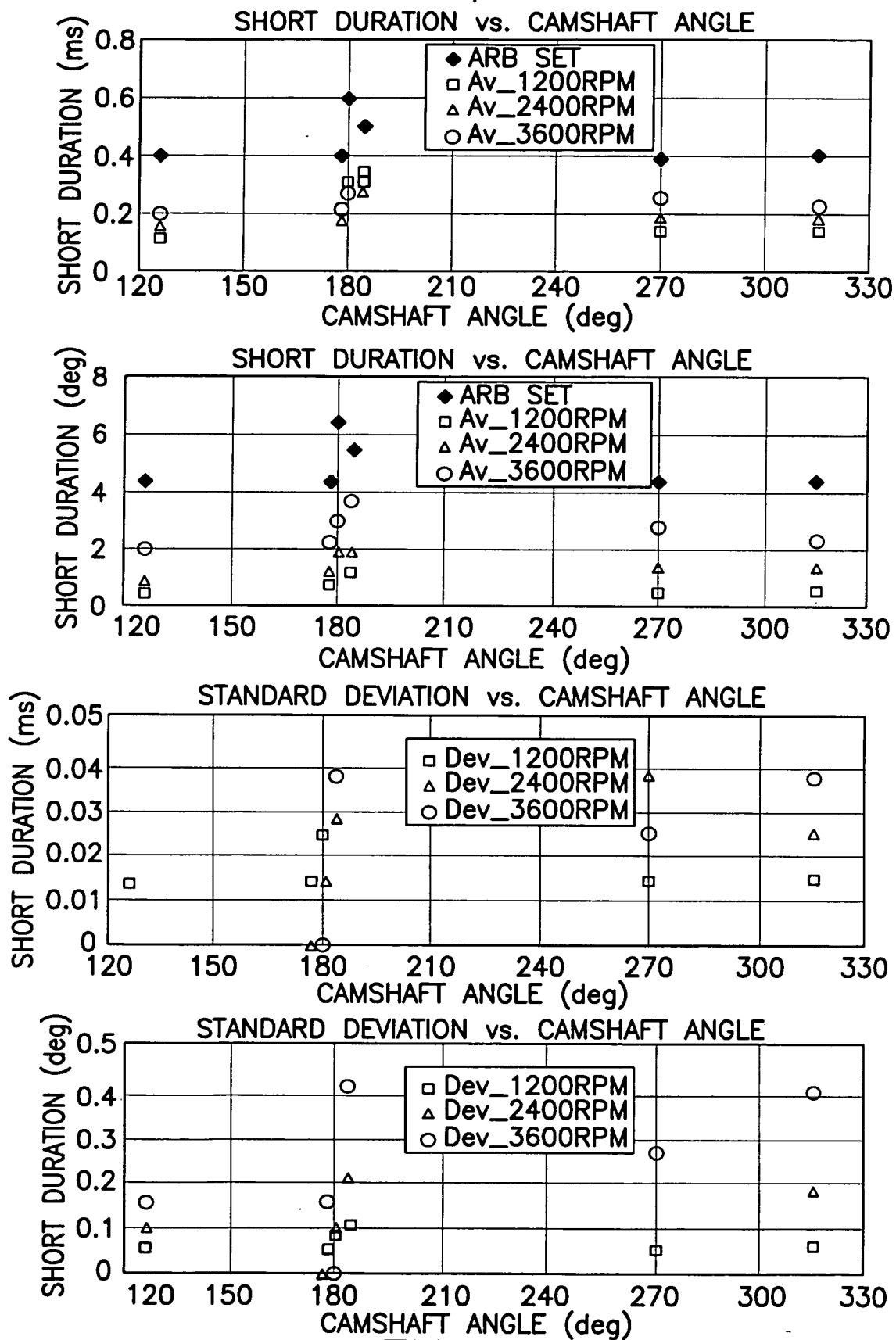


FIG.43

45/72

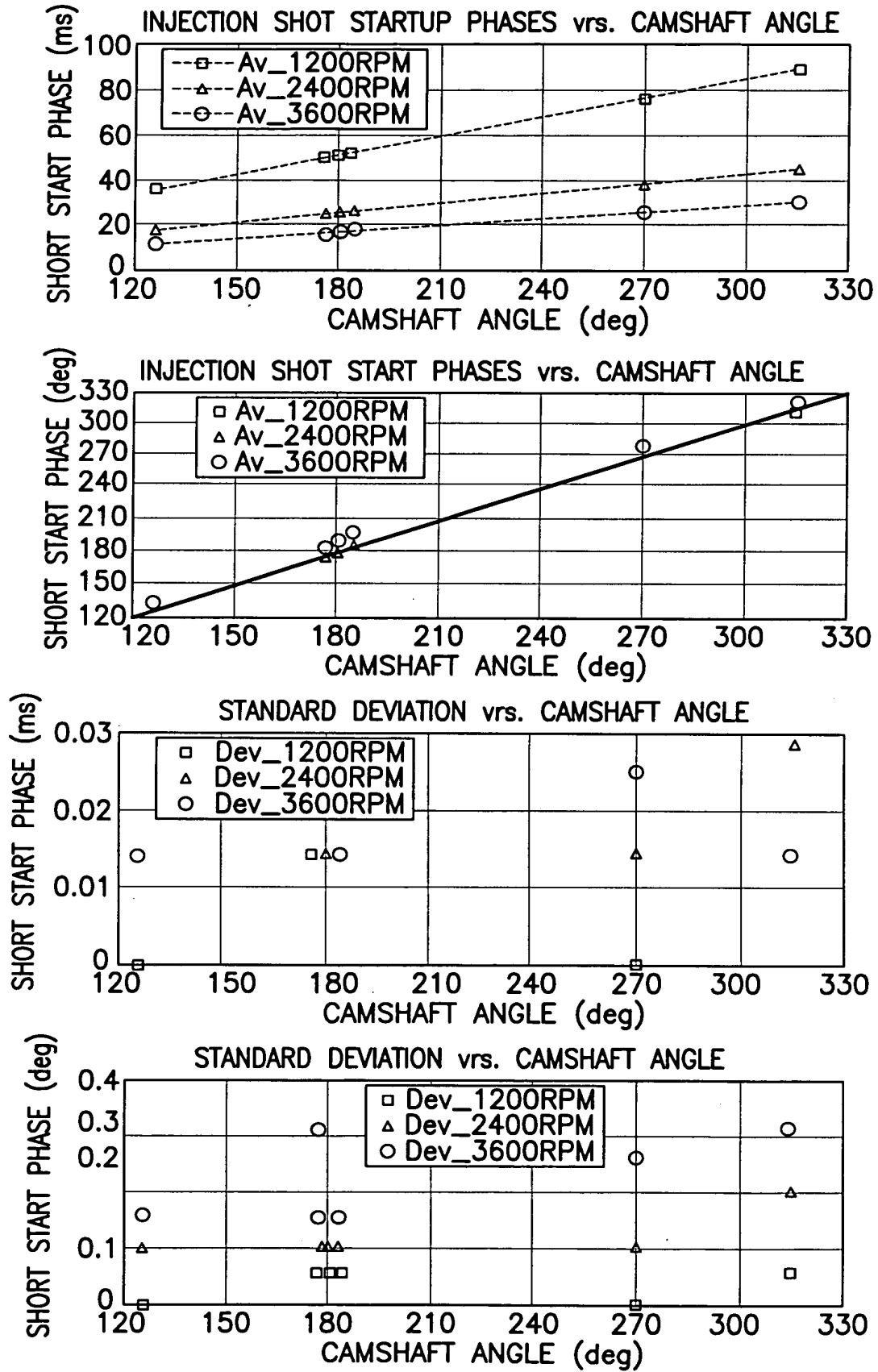
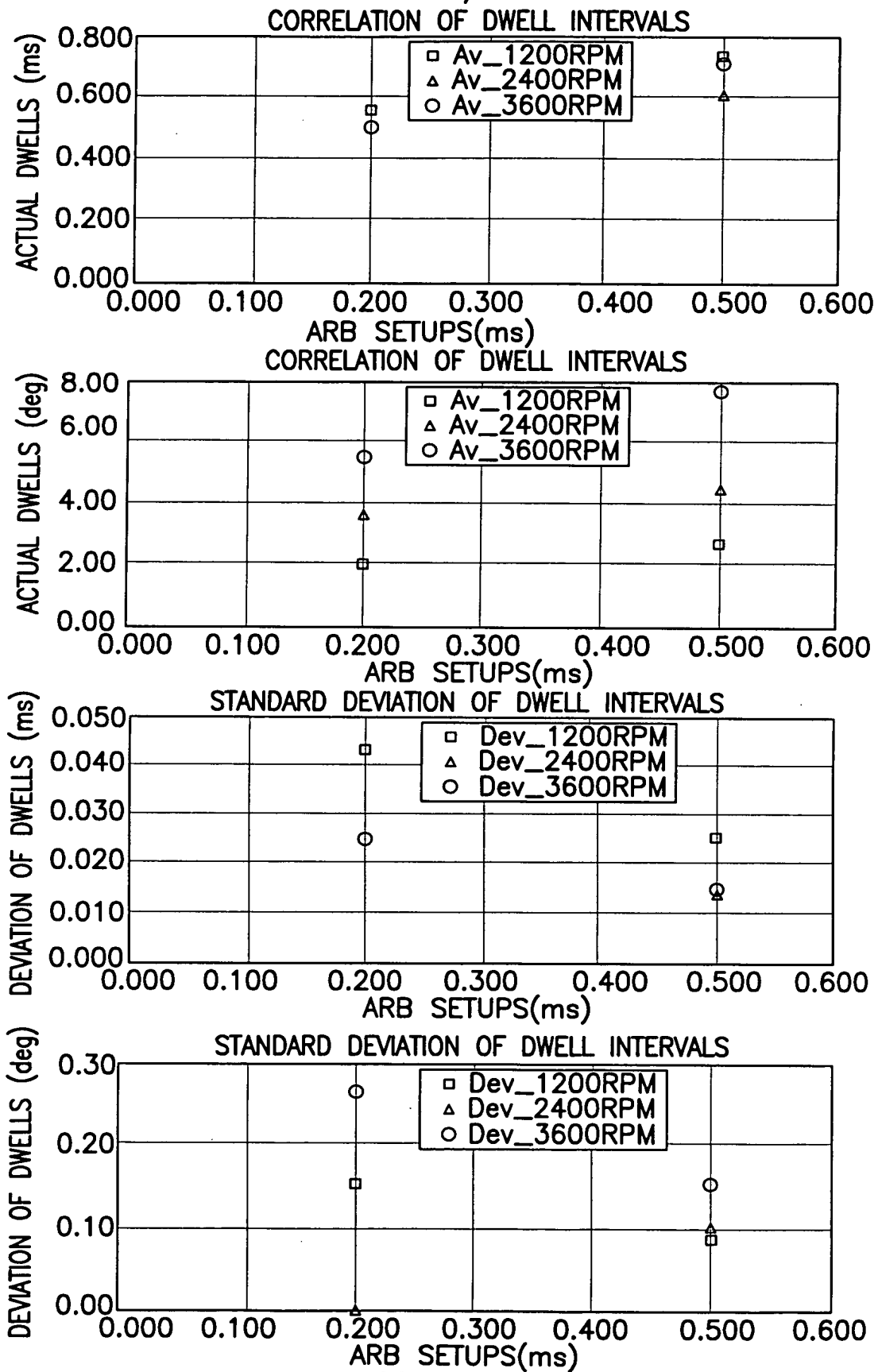


FIG.44

46/72



47/72

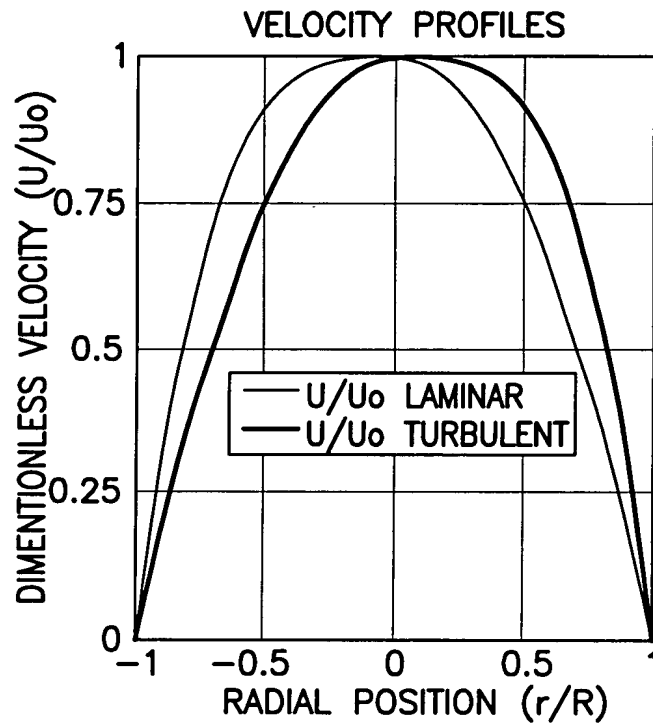


FIG.46

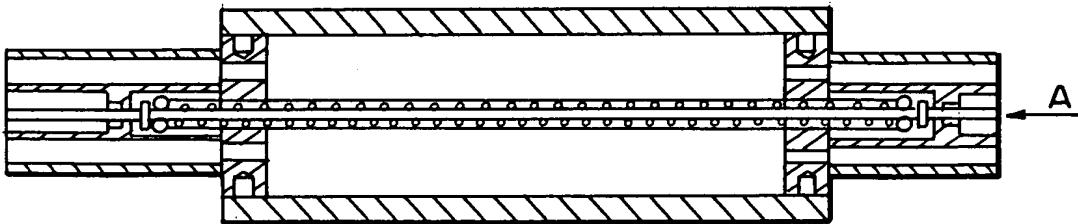


FIG.48

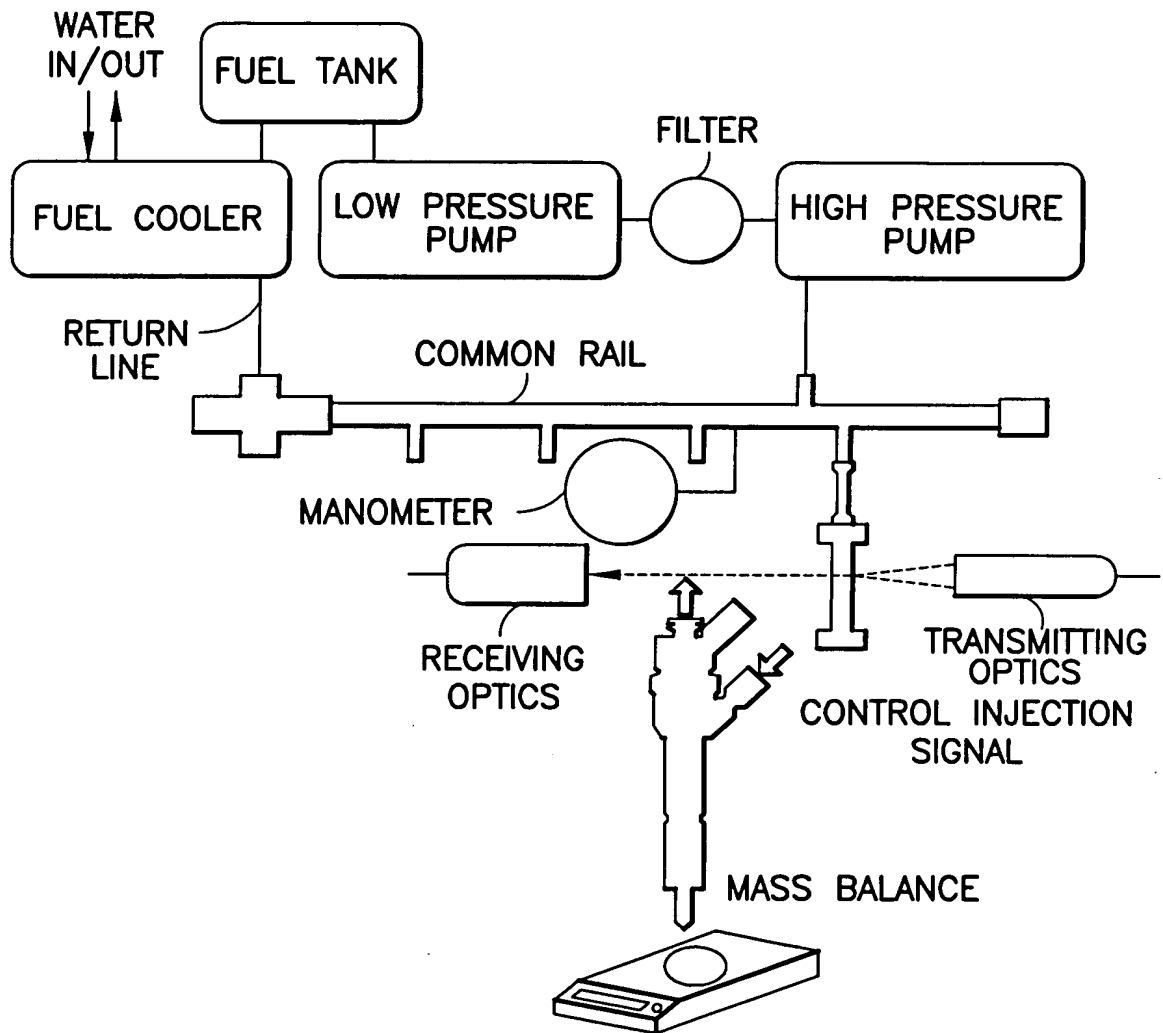


FIG.47

49/72

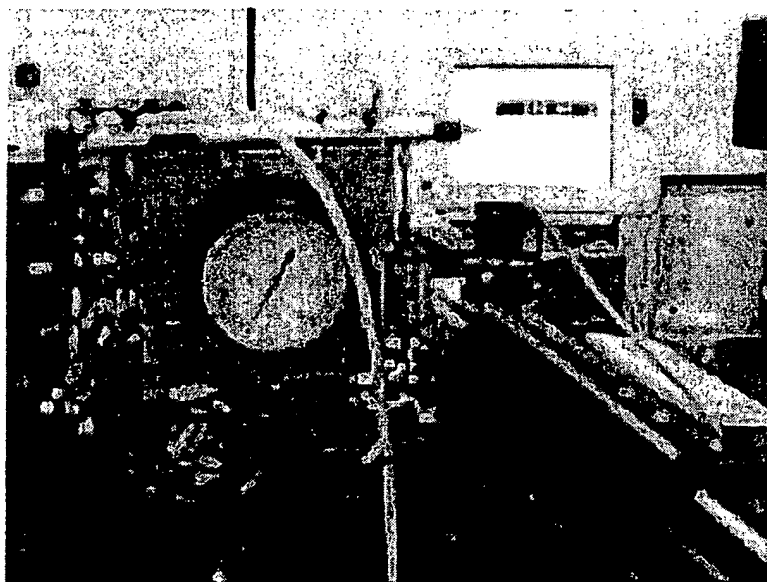


FIG.49

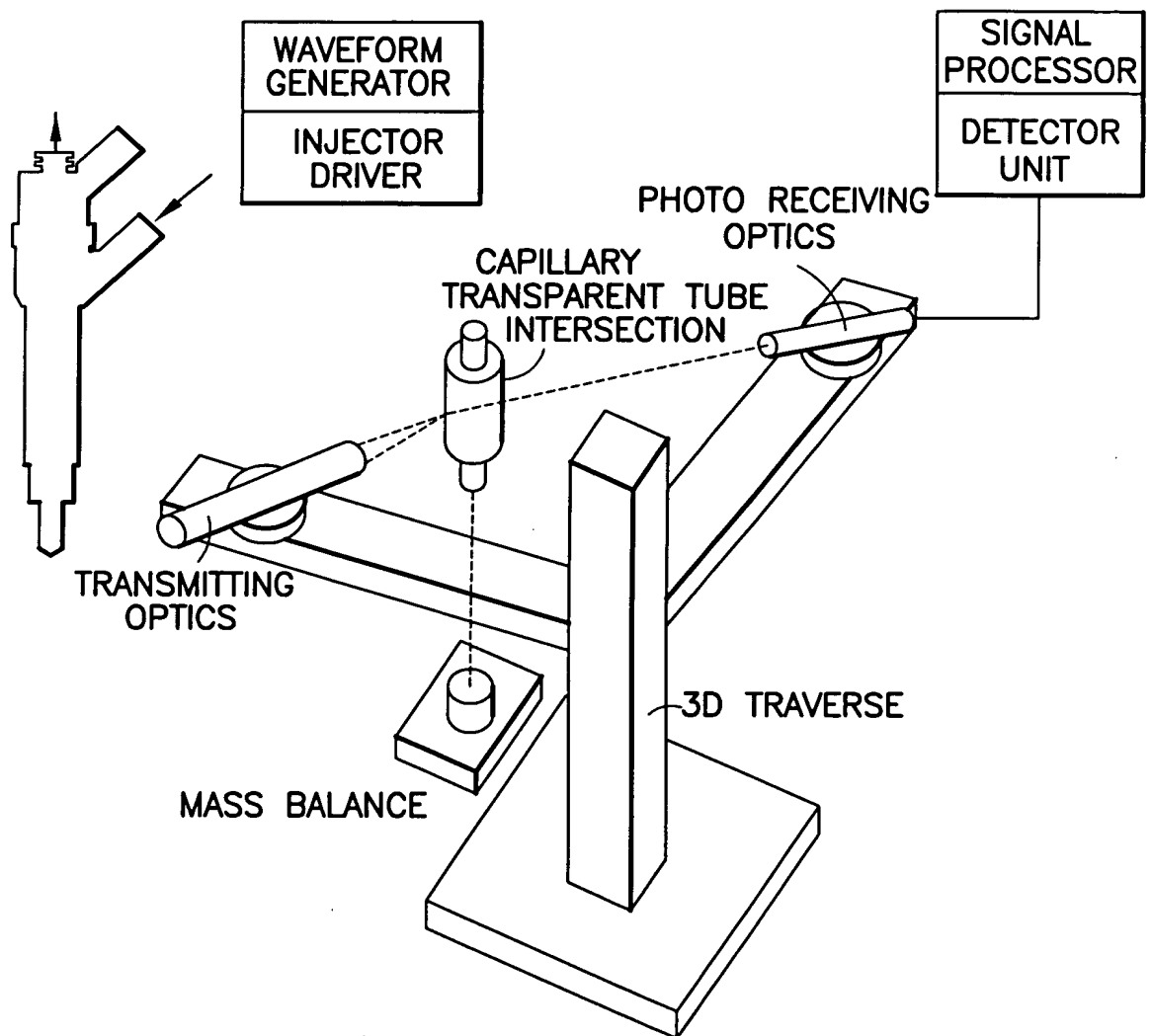


FIG.50

51/72

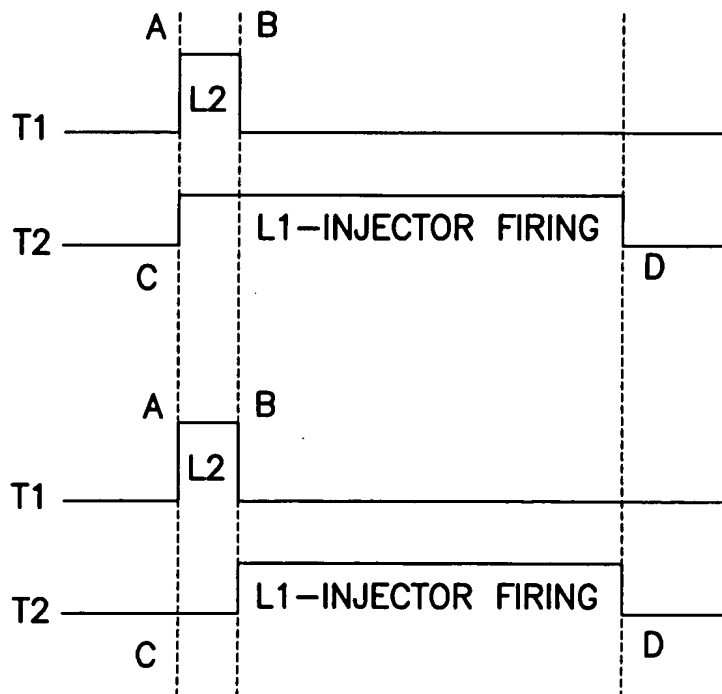
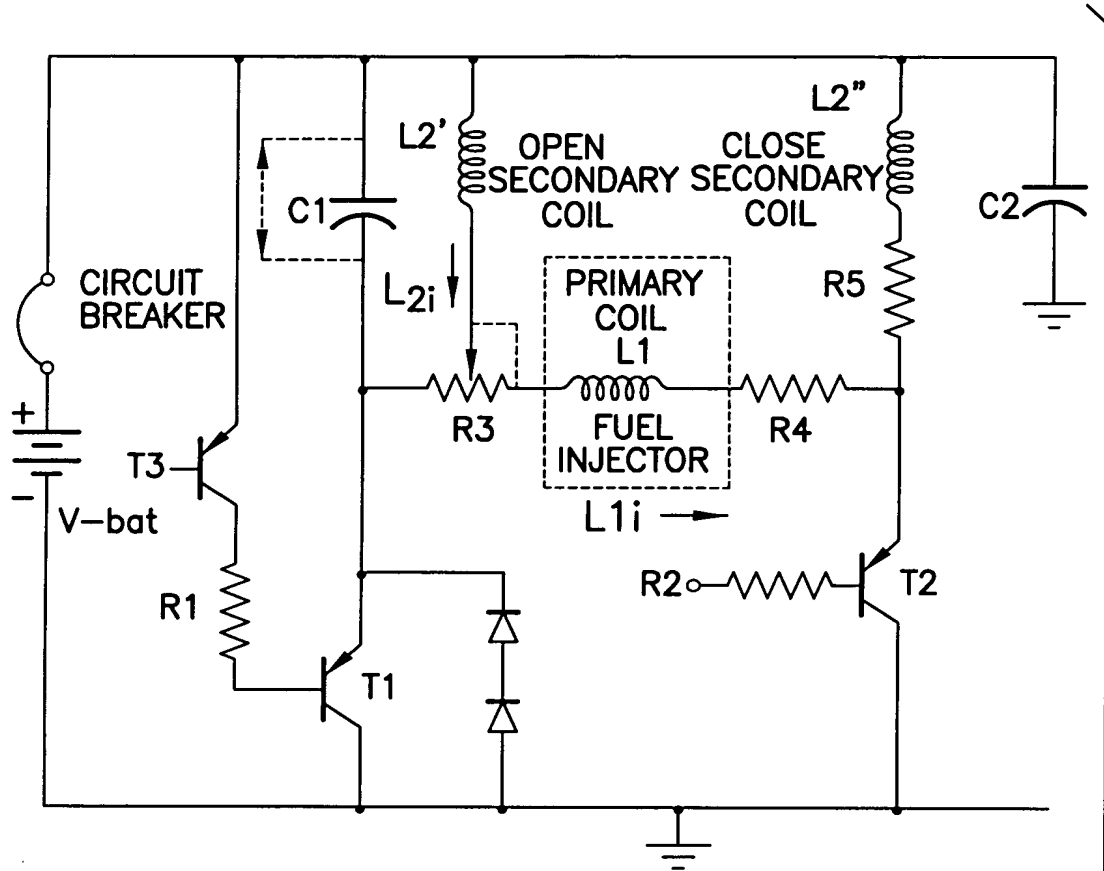


FIG.51

52/72

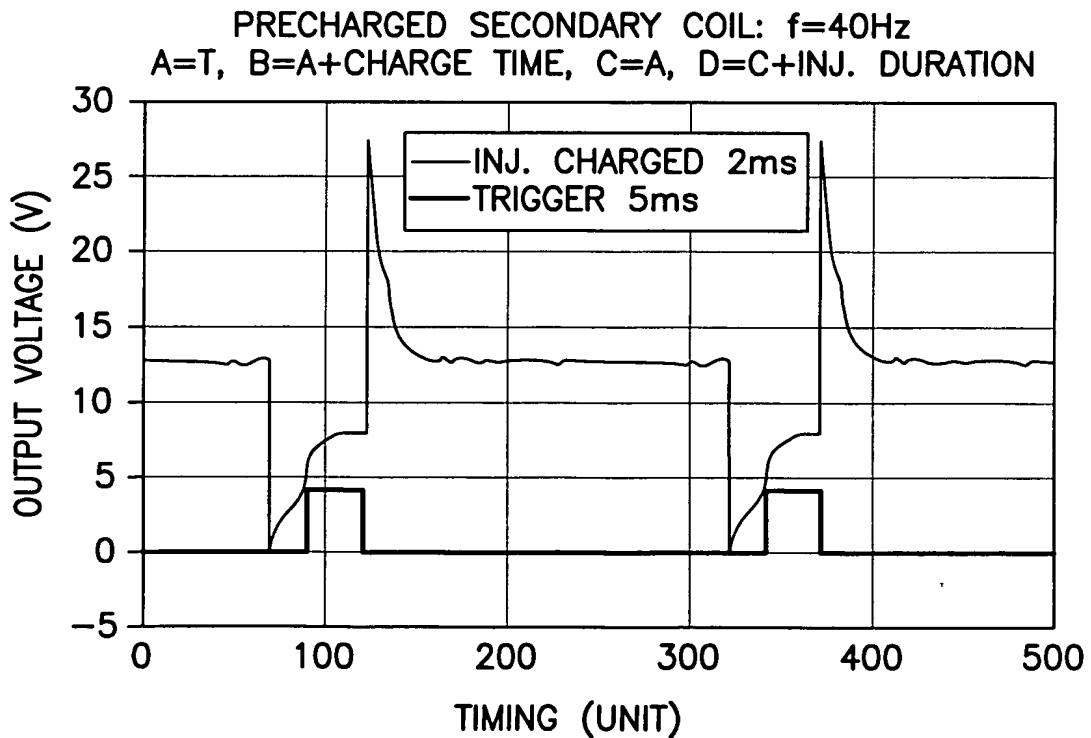
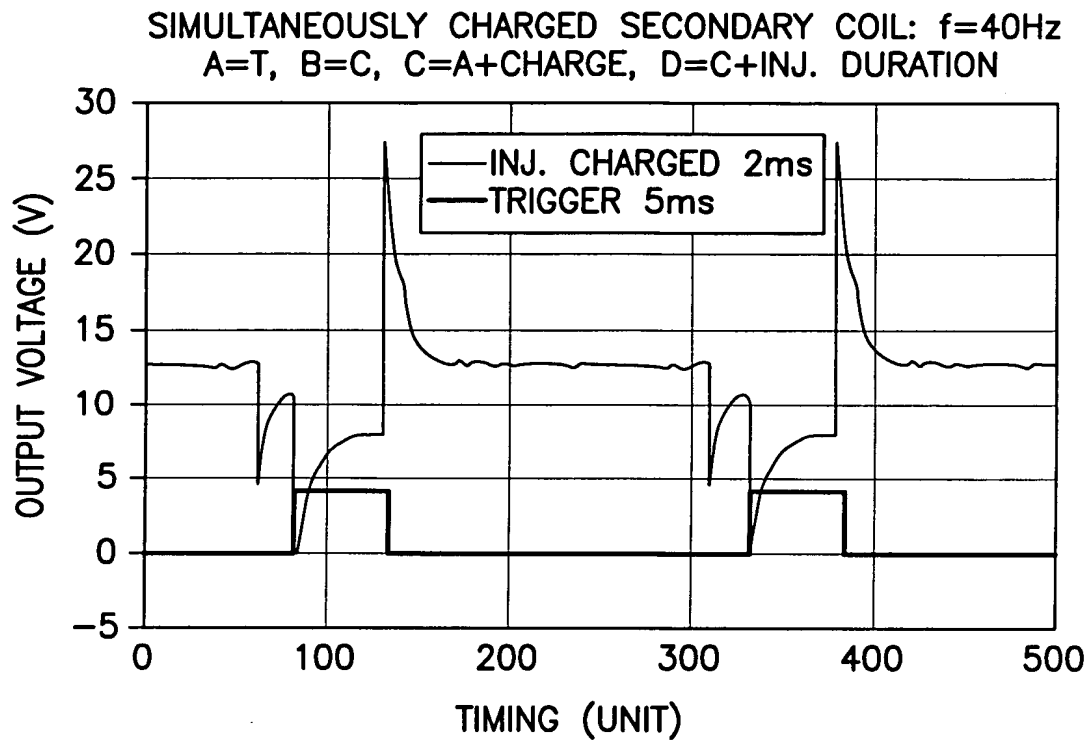


FIG.52

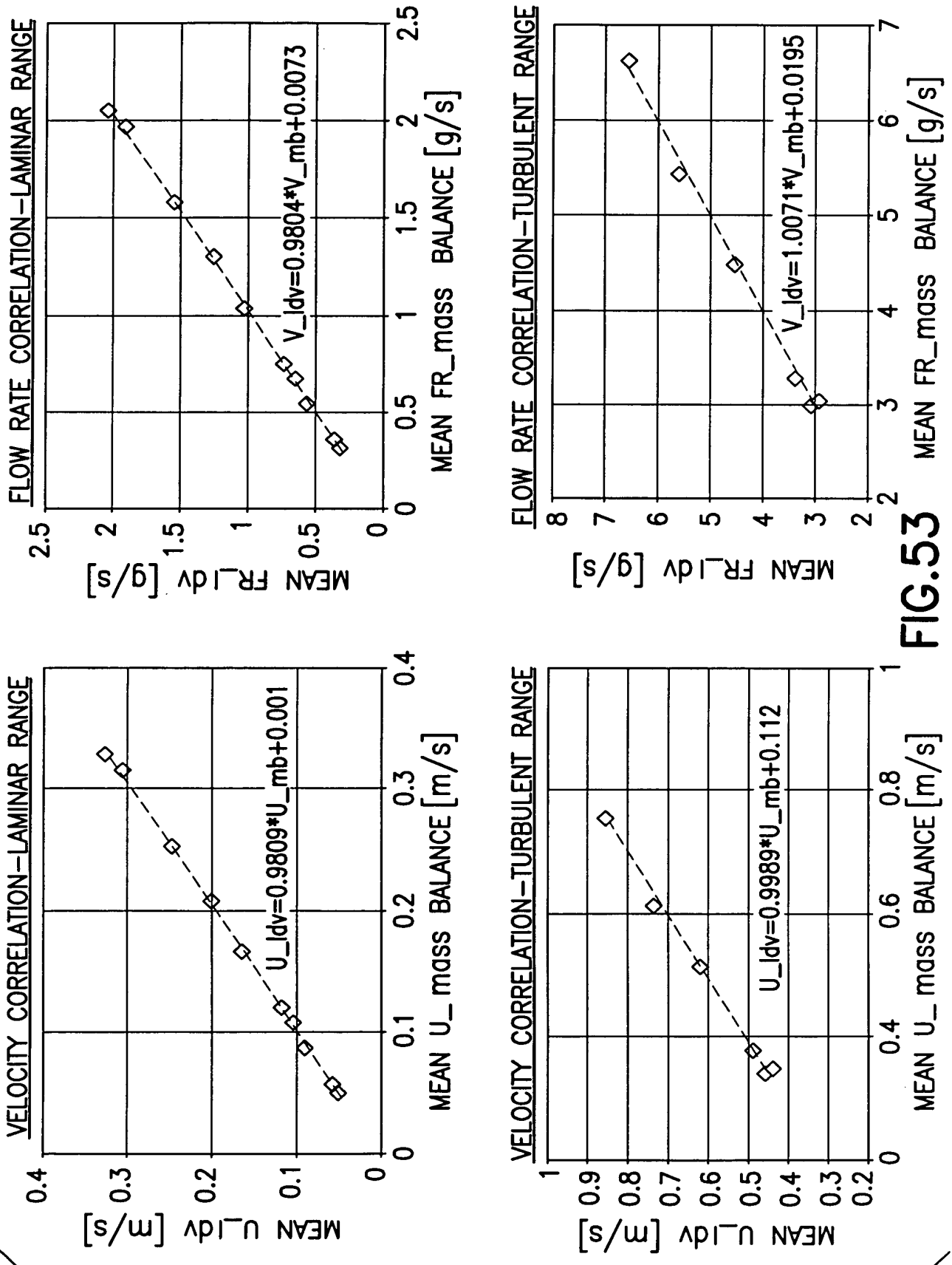


FIG.53

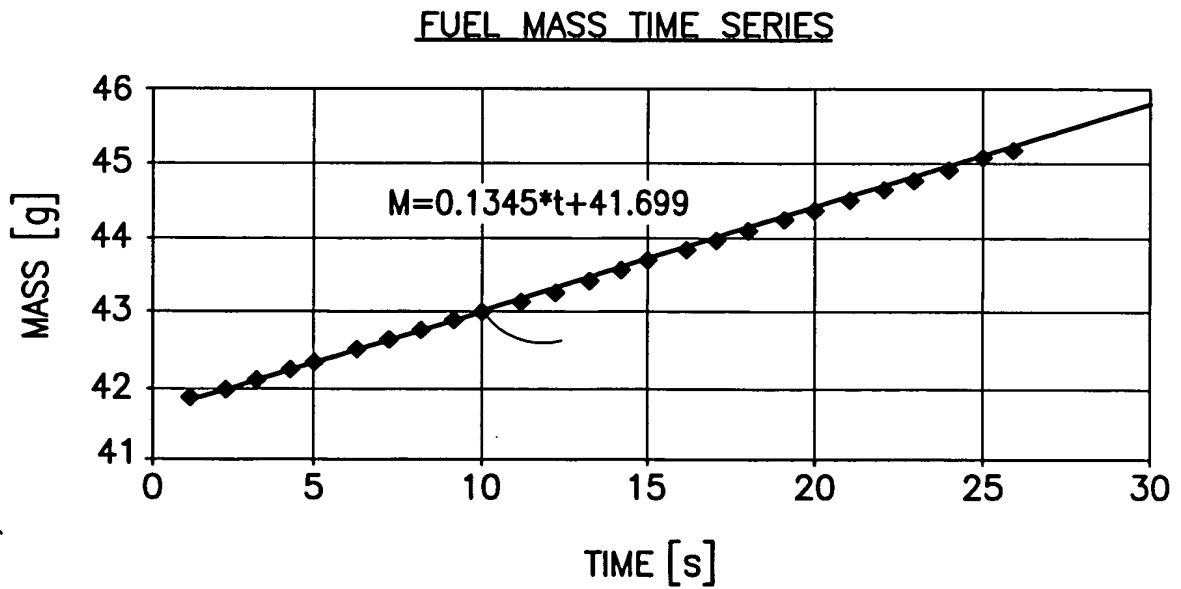
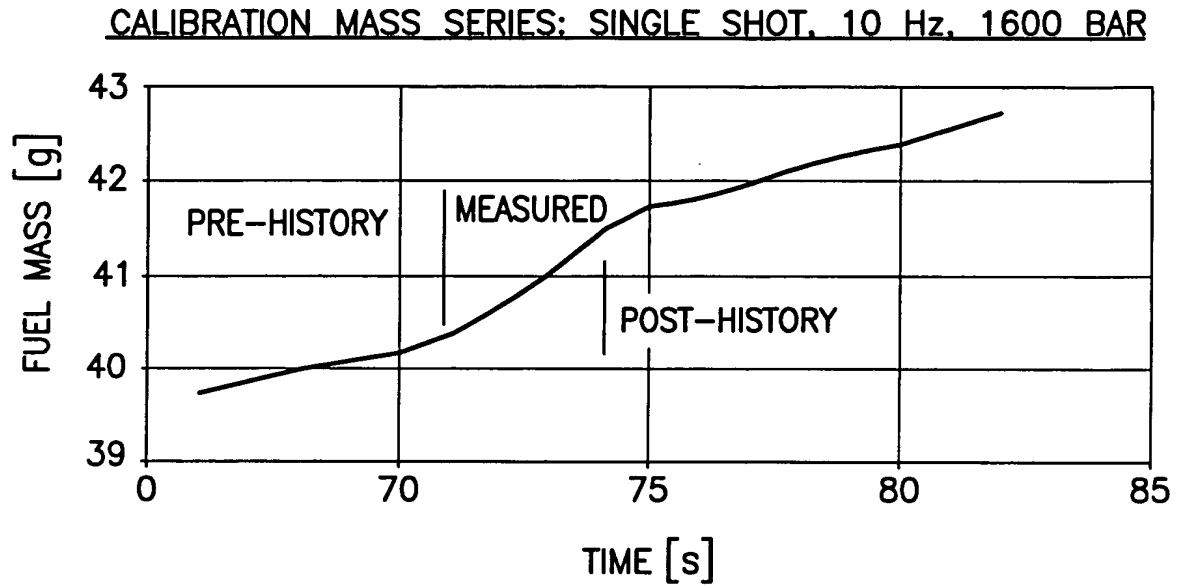


FIG.54

55/72

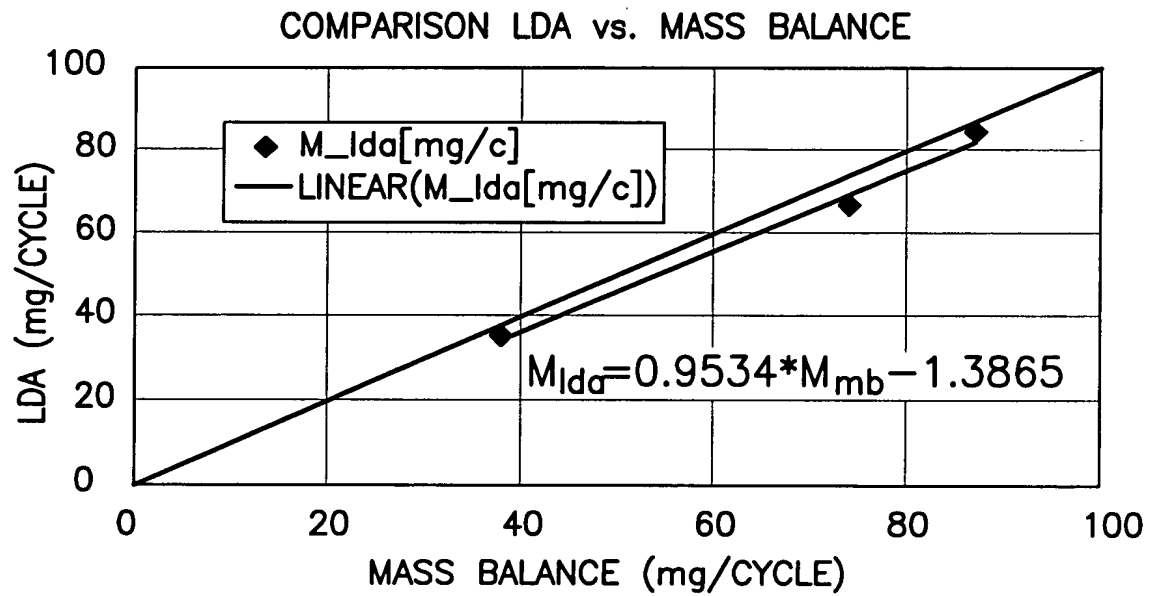


FIG.55

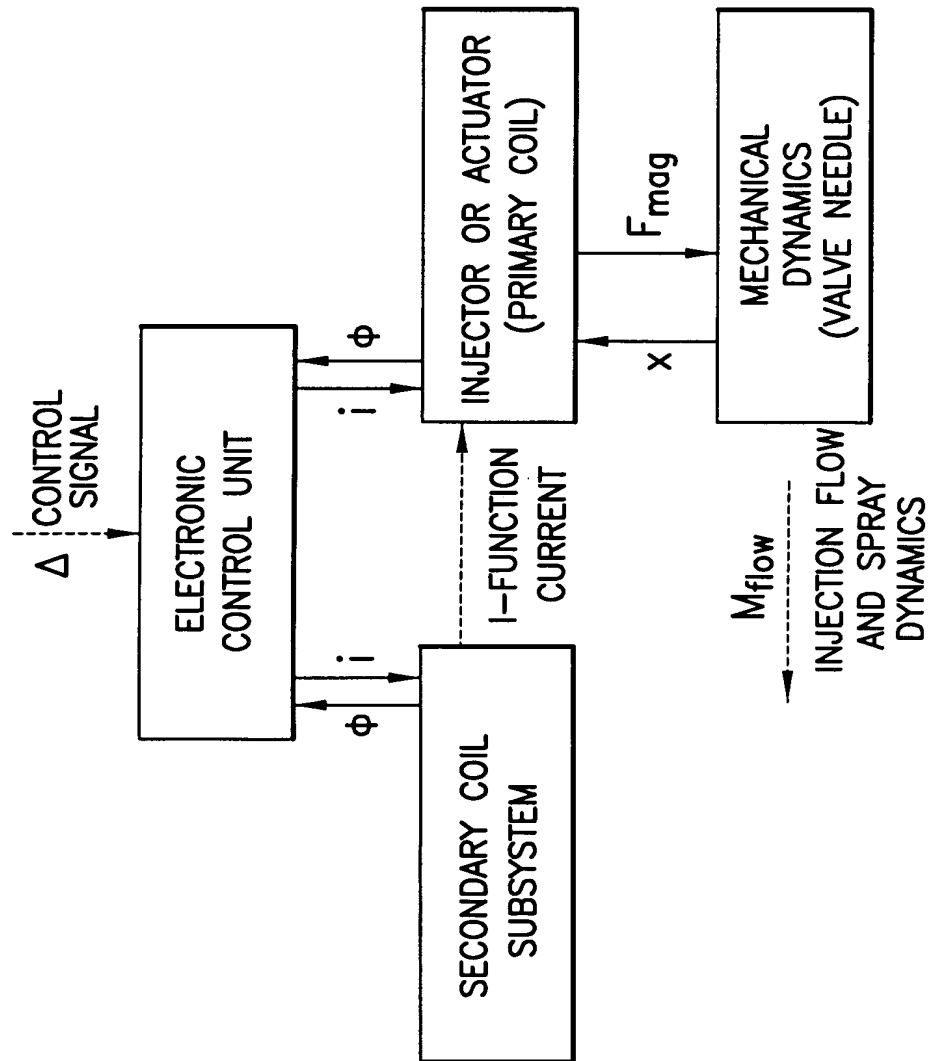
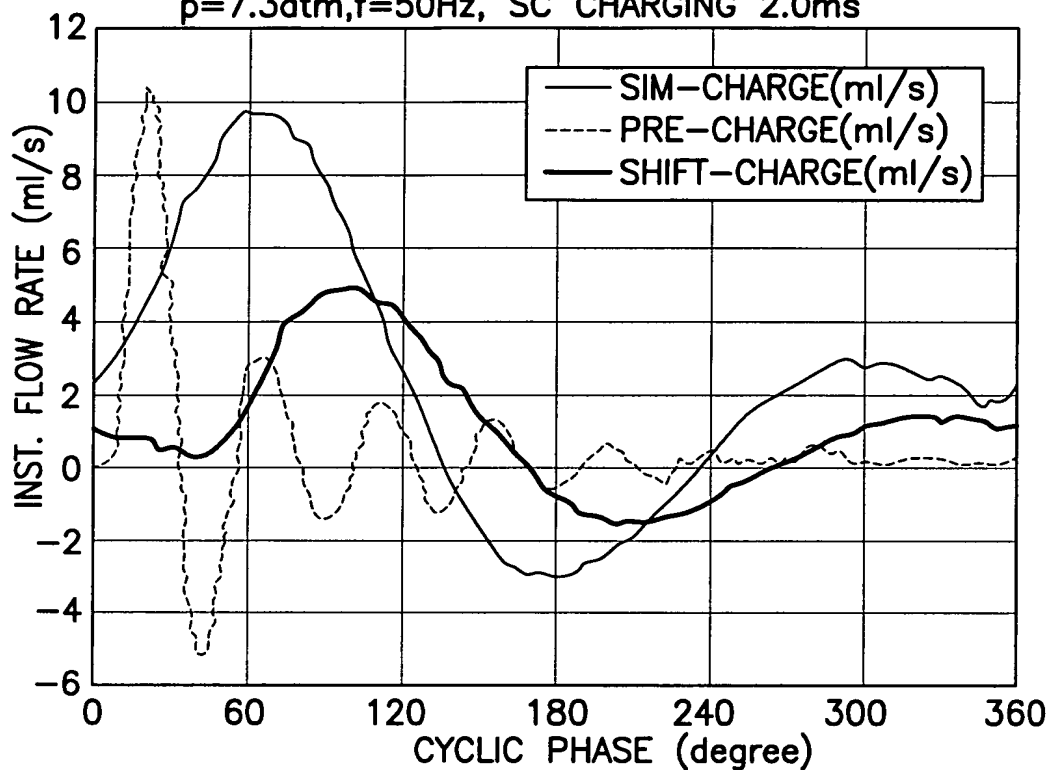


FIG.56

57/72

COMPARISON OF DIFFERENT CHARGING SCENARIOS:
 $p=7.3\text{atm}, f=50\text{Hz}$, SC CHARGING 2.0ms



COMPARISON OF DIFFERENT SC CHARGING SCENARIOS:
 $p=7.3\text{atm}, f=50\text{Hz}$, SC CHARGING 2.0ms, $\tau=3\&5\text{ms}$

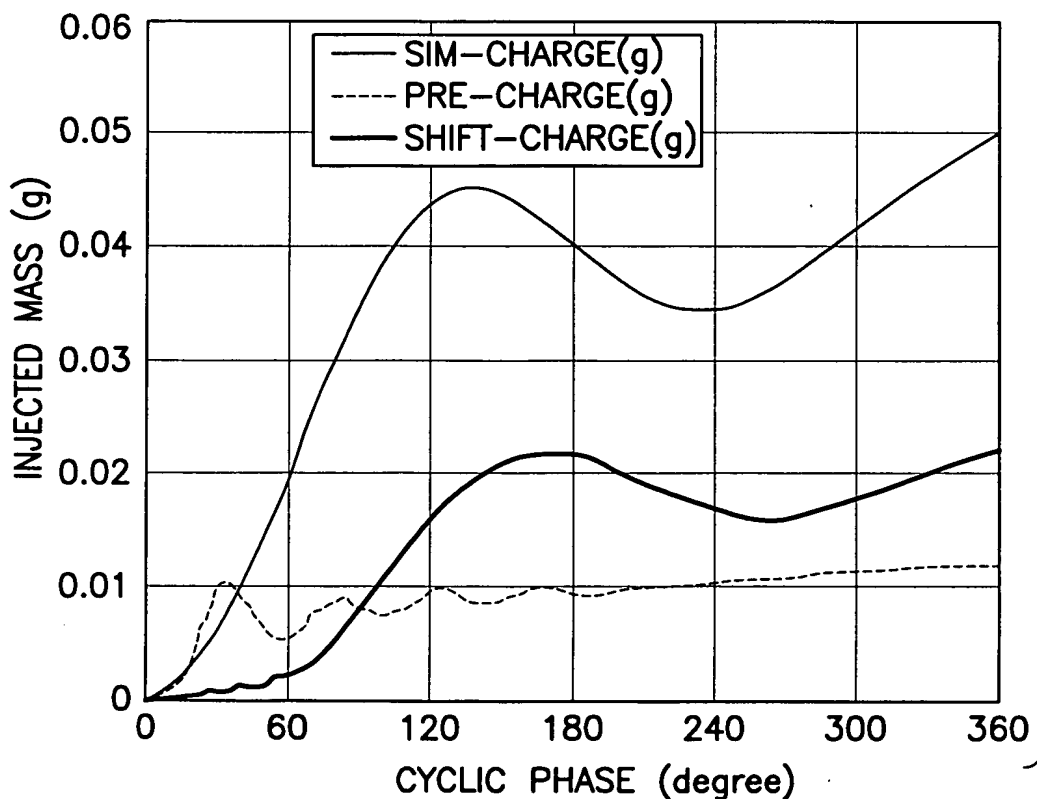
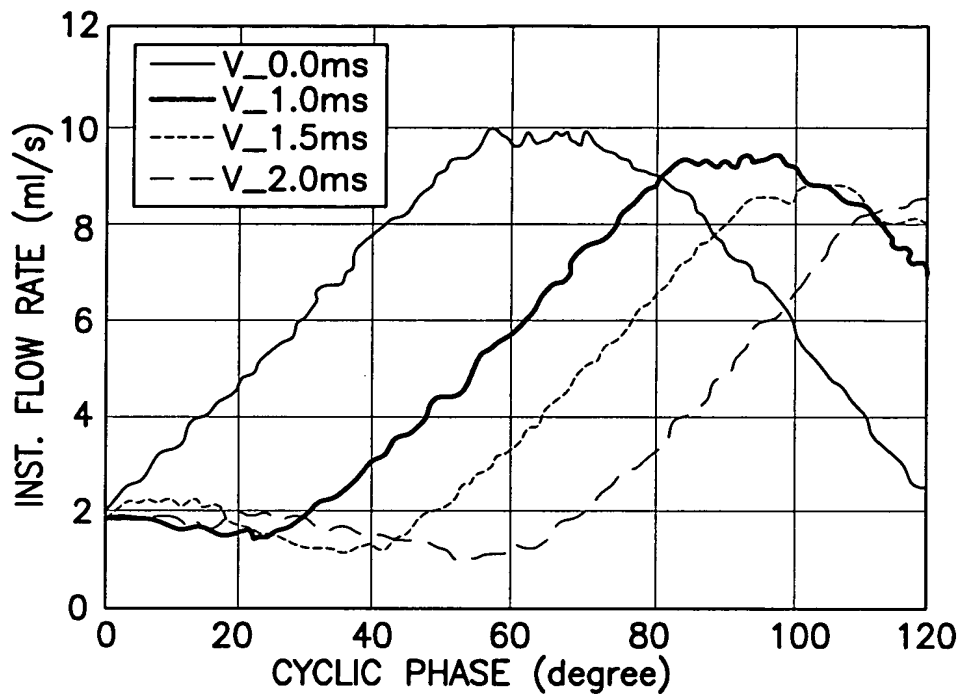


FIG.57

58/72

SIMULTANEOUSLY CHARGED SC: CHARGING 0.0, 1.0,
1.5 AND 2.0ms; $f=50\text{Hz}$, $\tau=5\text{ms}$, $p=7.3\text{atm}$



SIMULTANEOUSLY CHARGED SC: CHARGING 0.0, 1.0,
1.5 AND 2.0ms; $f=50\text{Hz}$, $\tau=5\text{ms}$, $p=7.3\text{atm}$

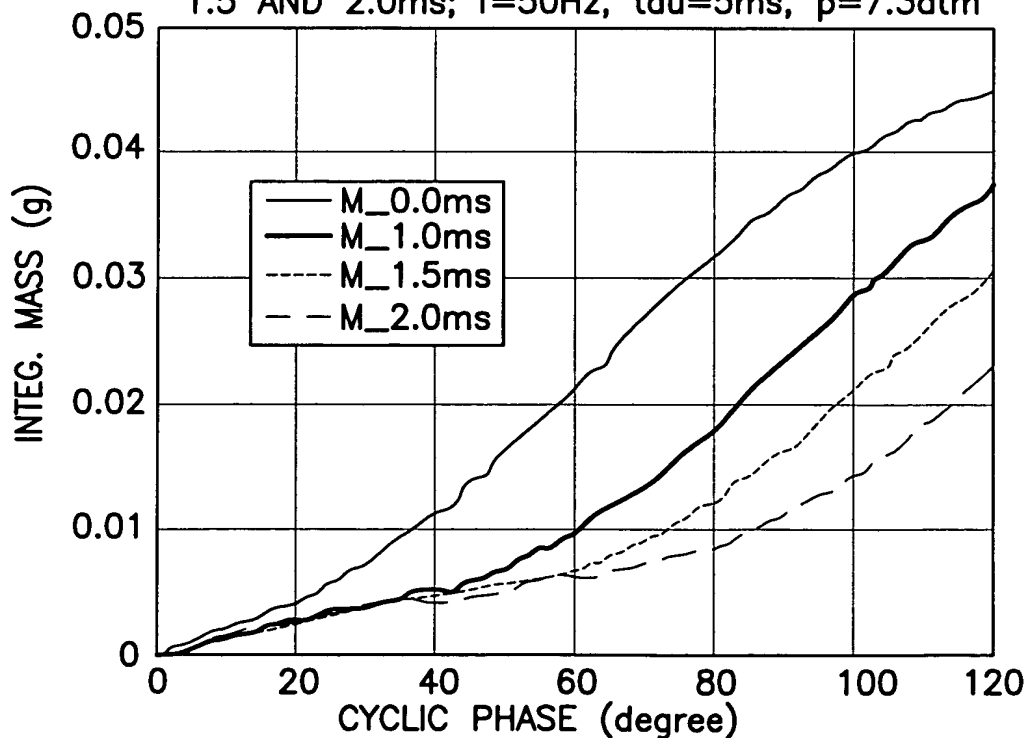


FIG.58A

59/72

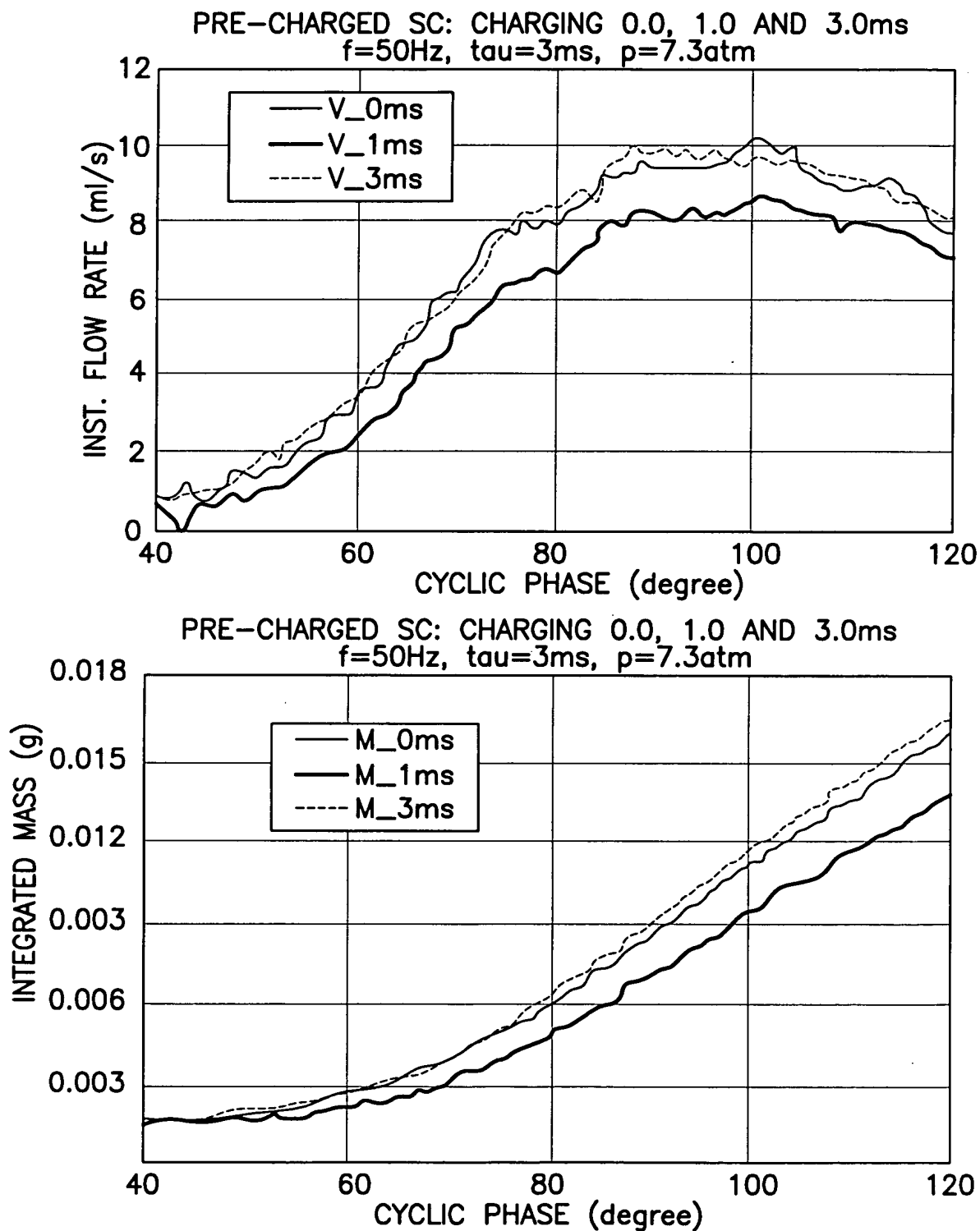


FIG.58B

60/72

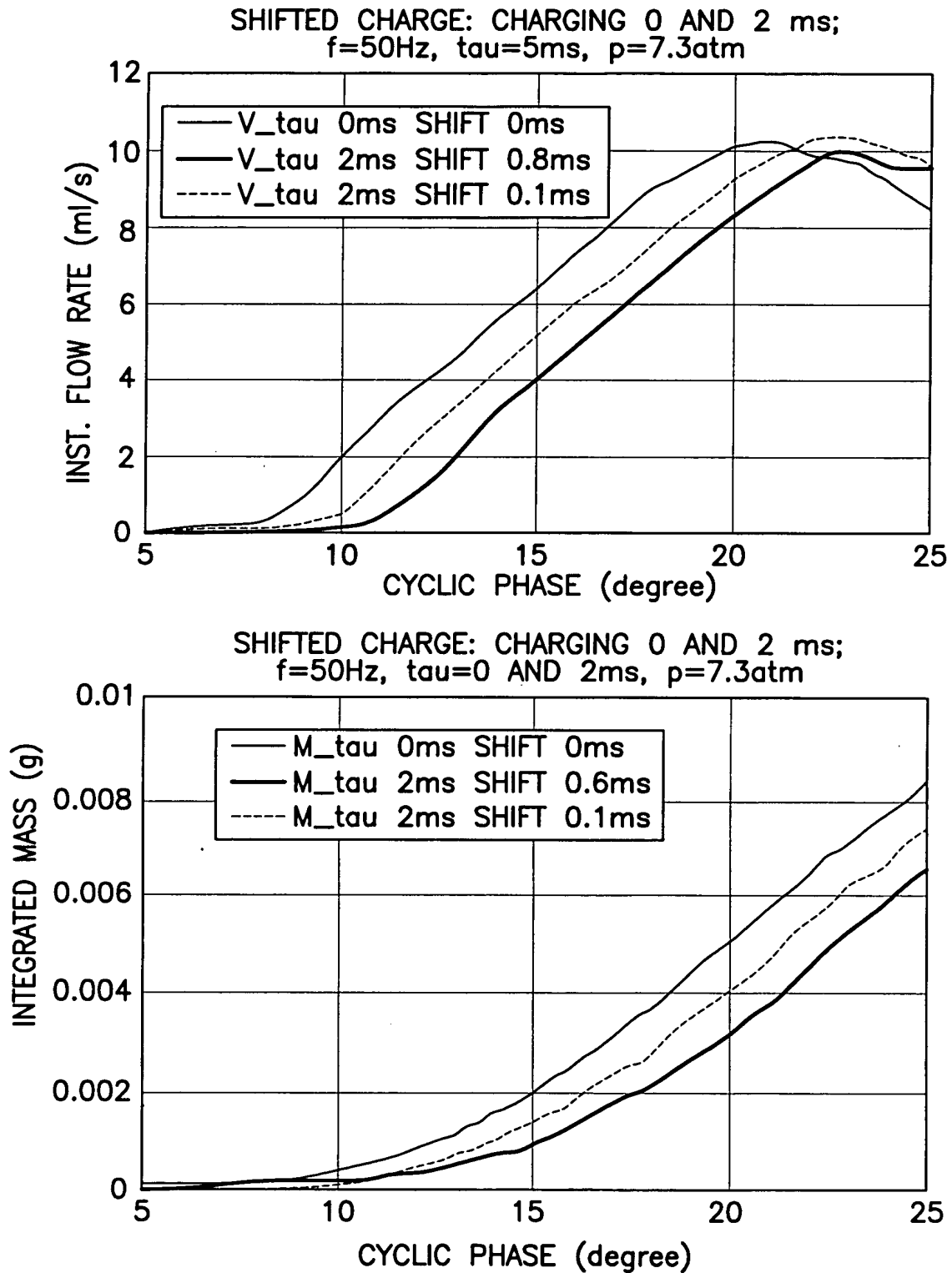


FIG.58C

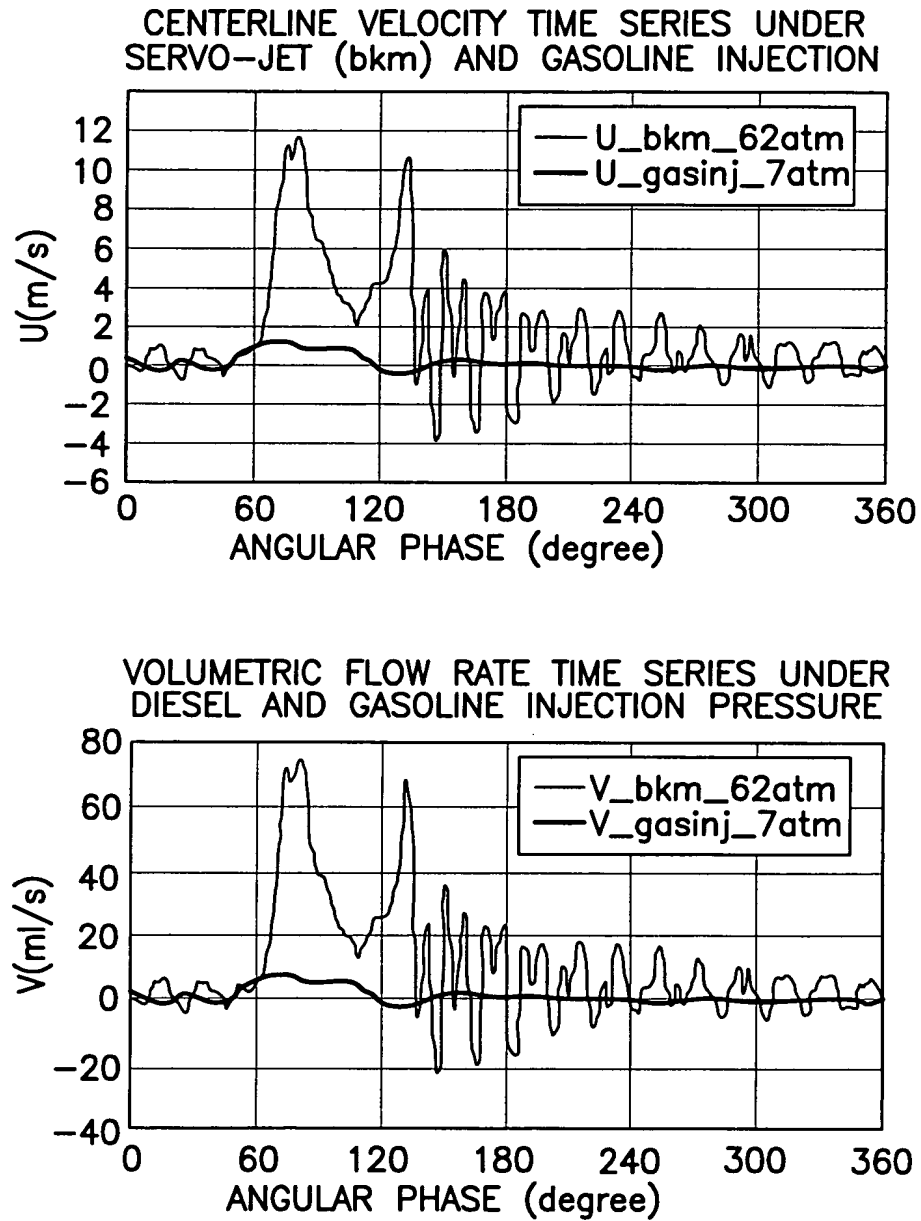


FIG.59

62/72

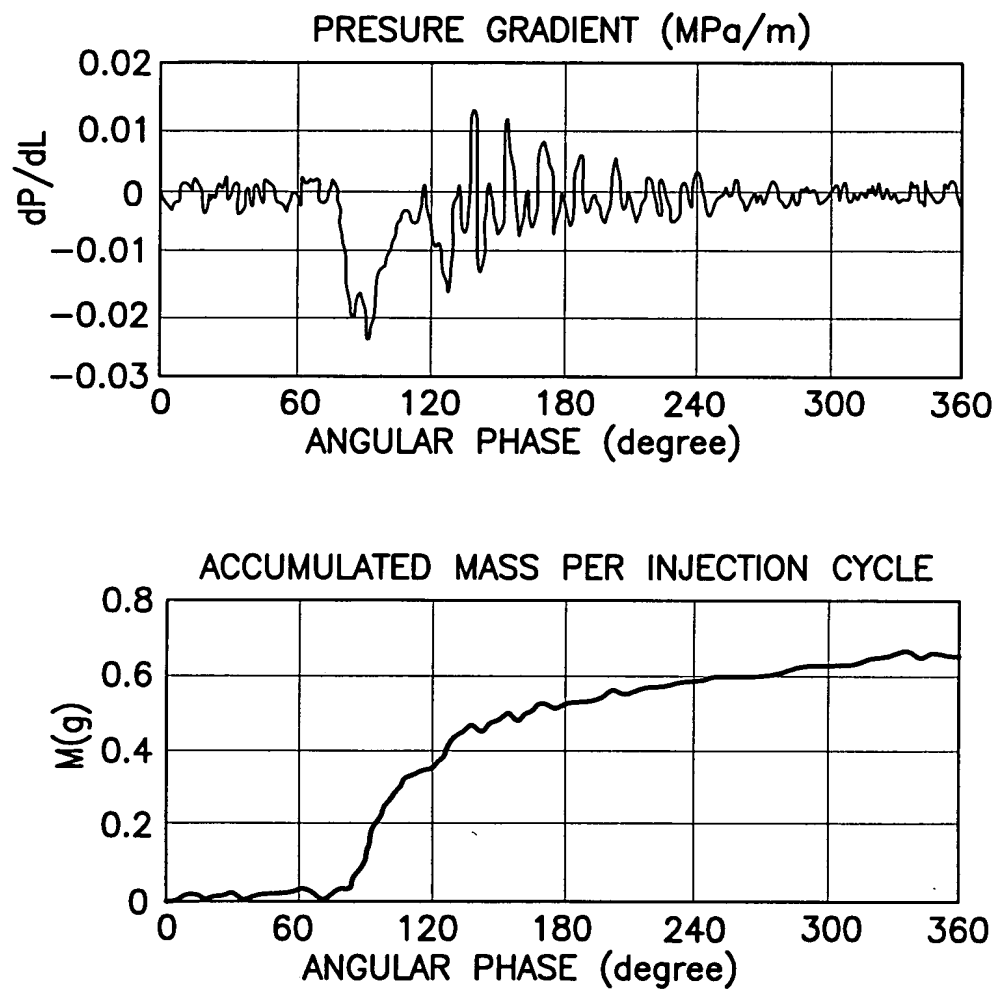


FIG.60

63/72

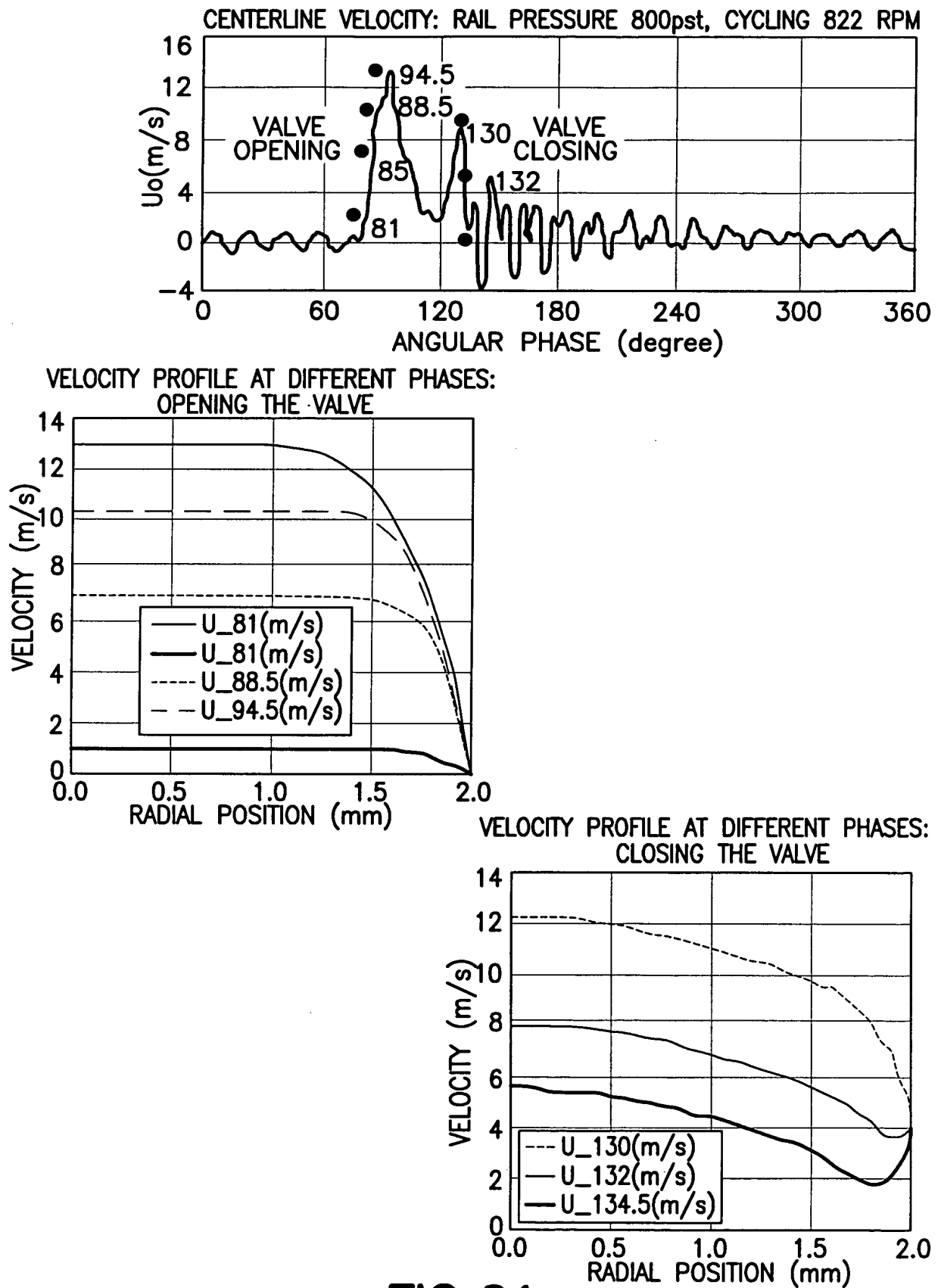


FIG.61

64/72

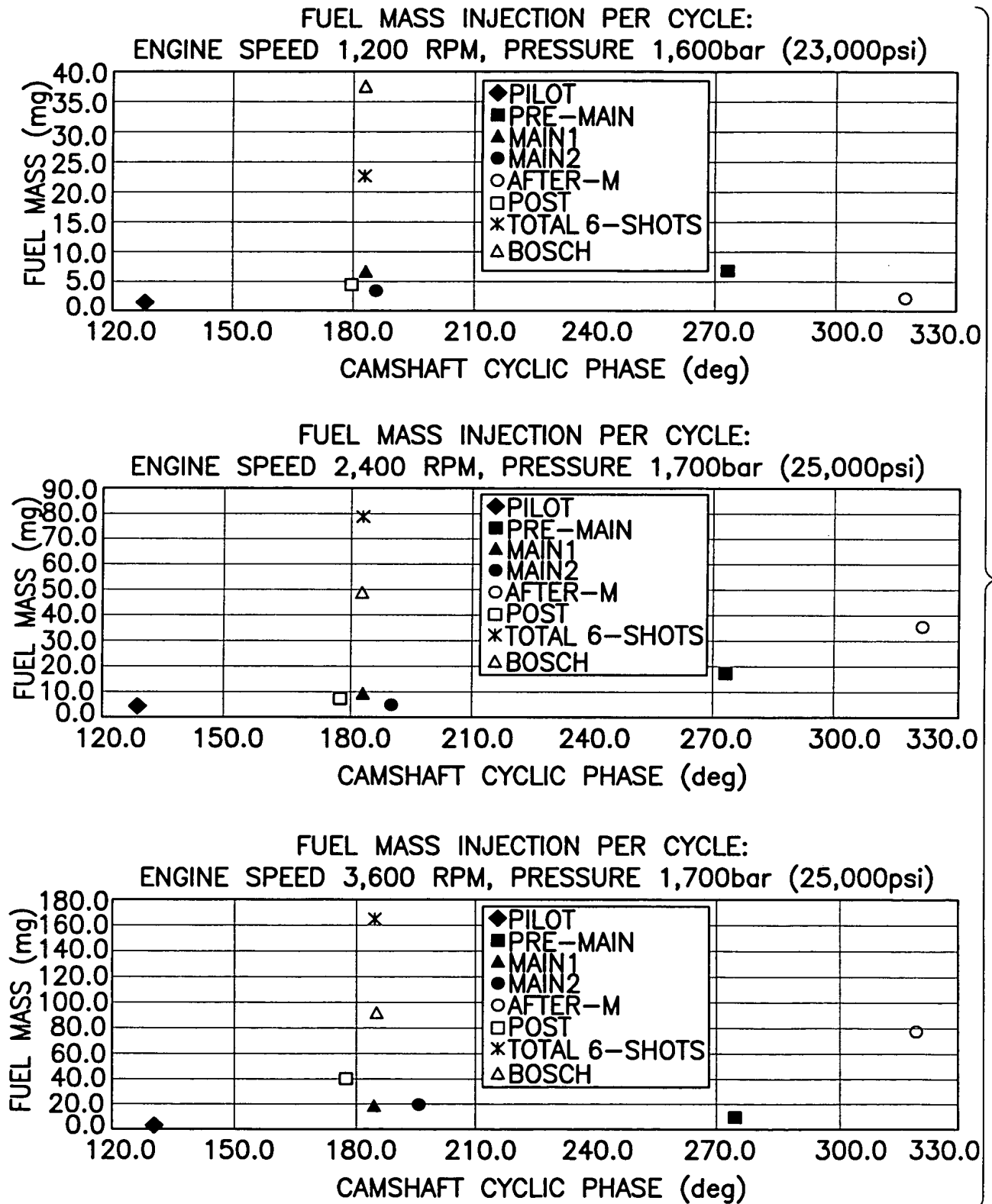


FIG.62

65/72

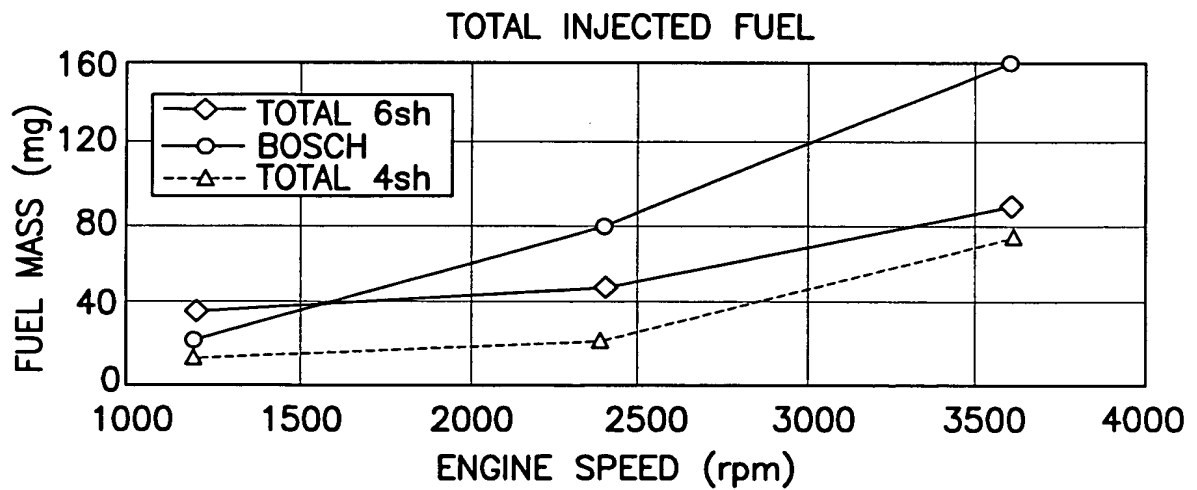
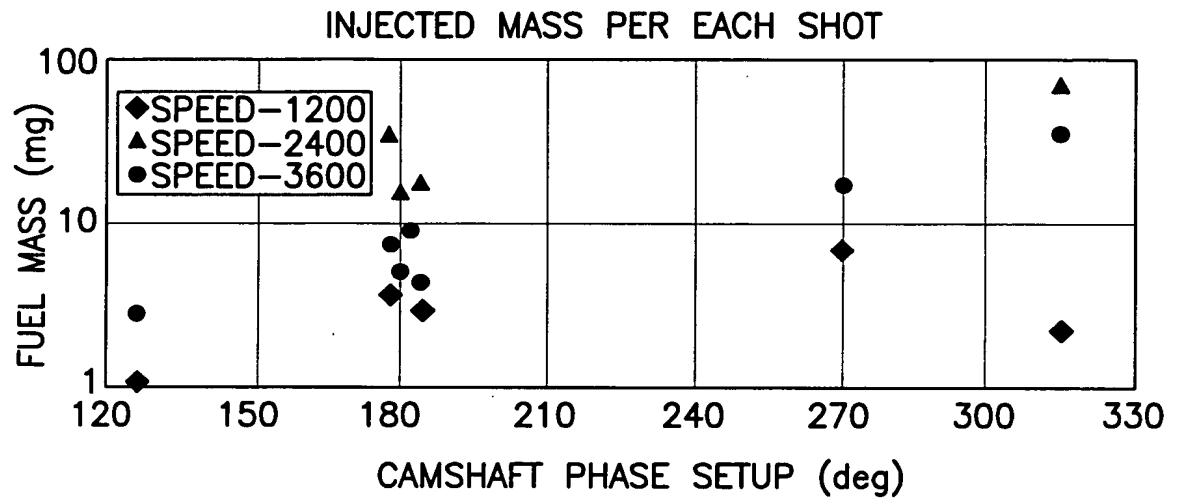


FIG.63

66/72

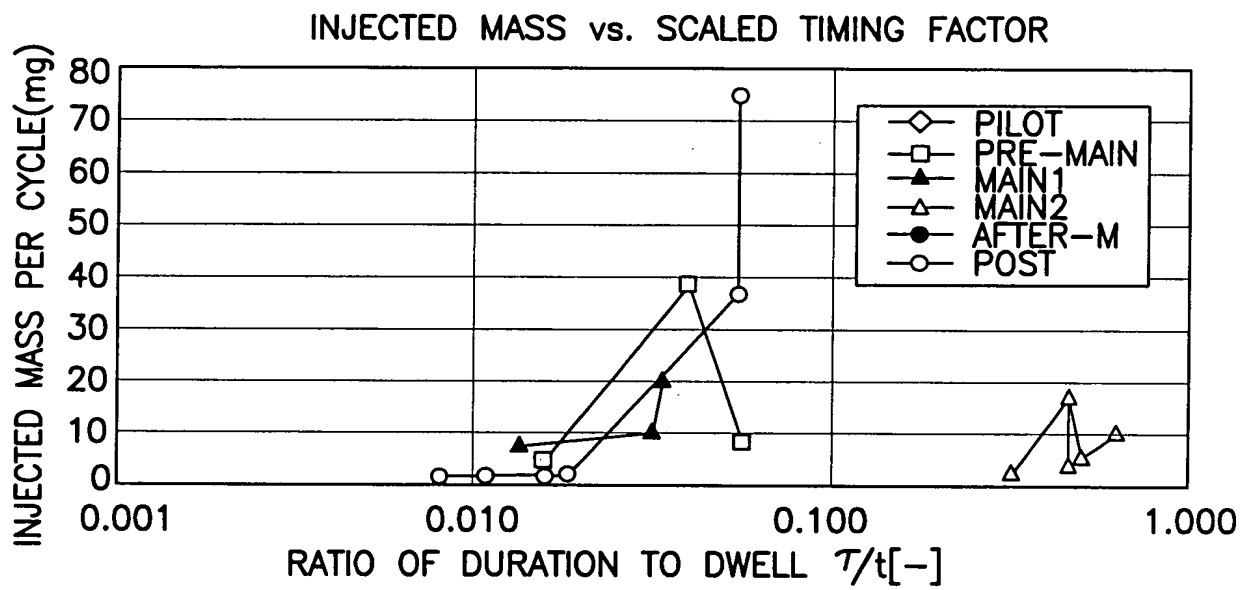


FIG.64

67/72

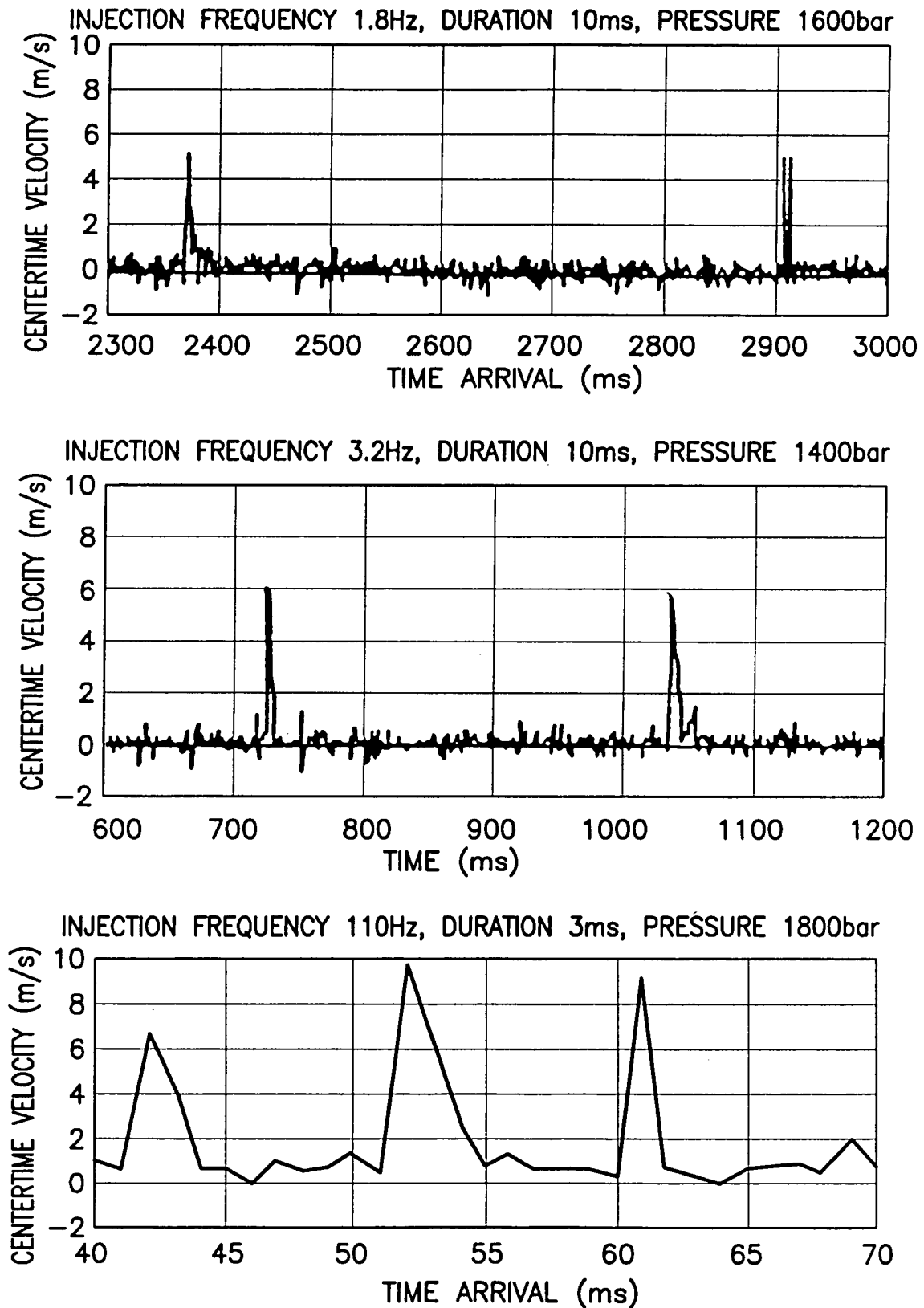


FIG.65

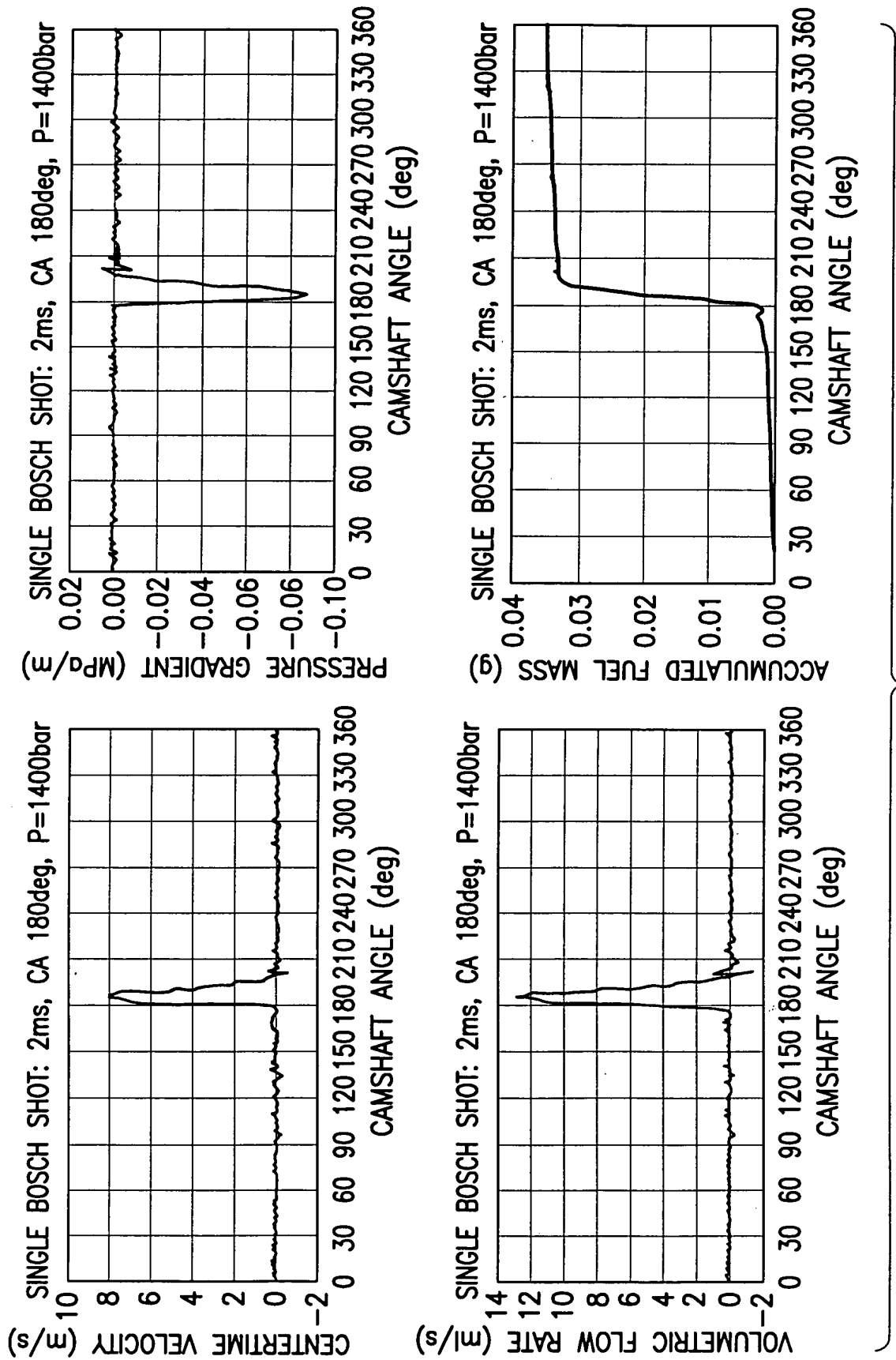
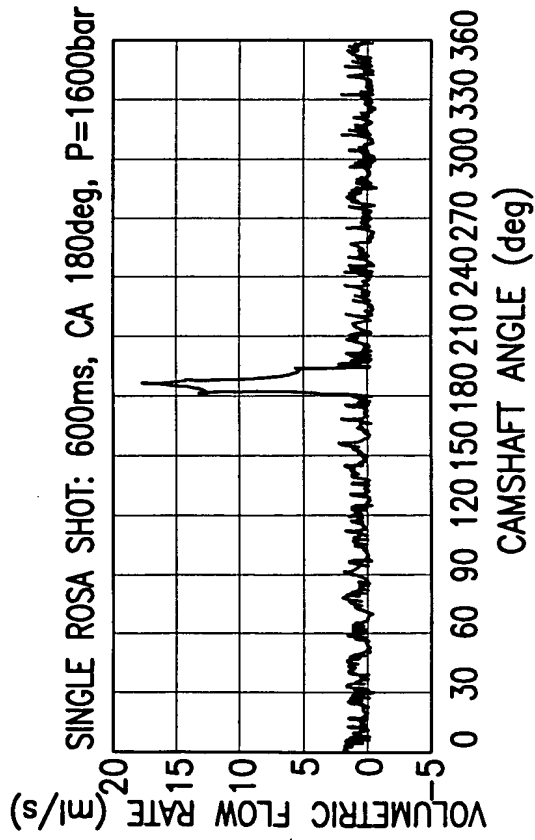
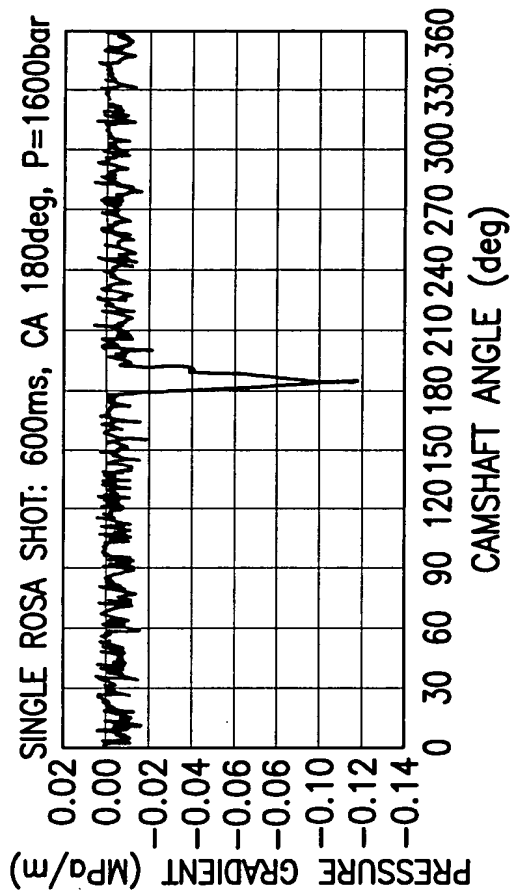
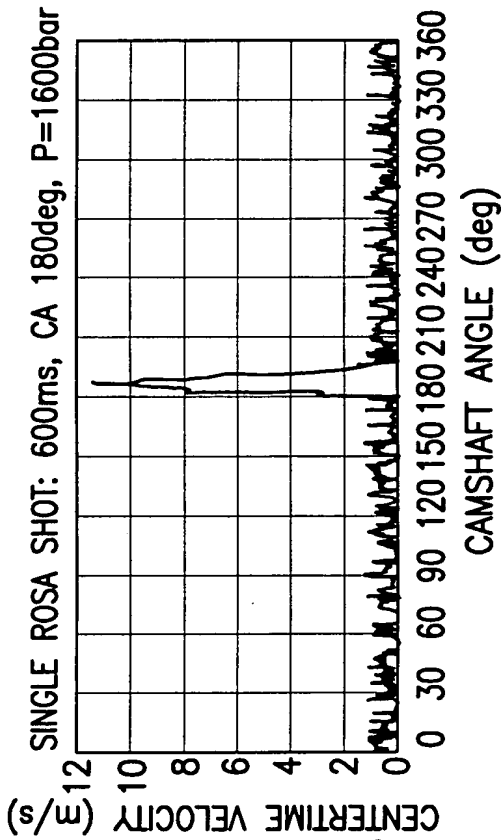
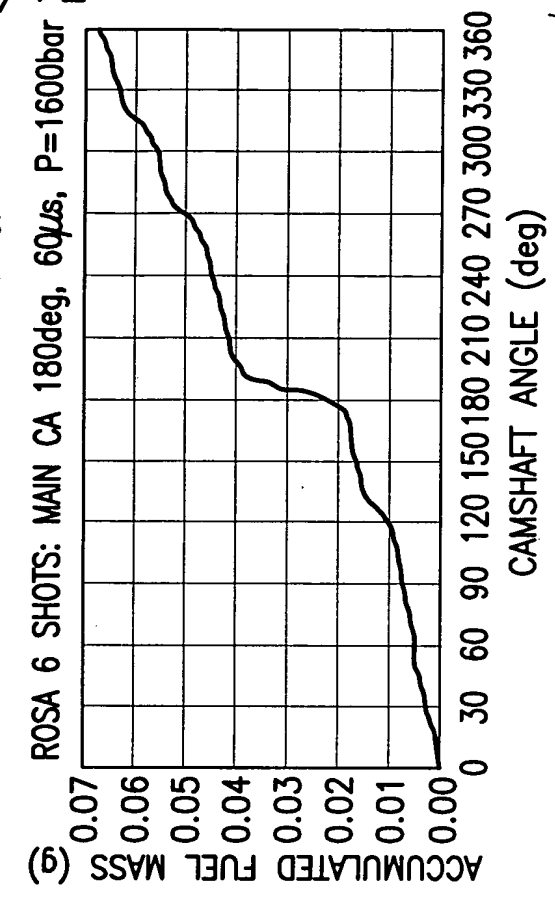
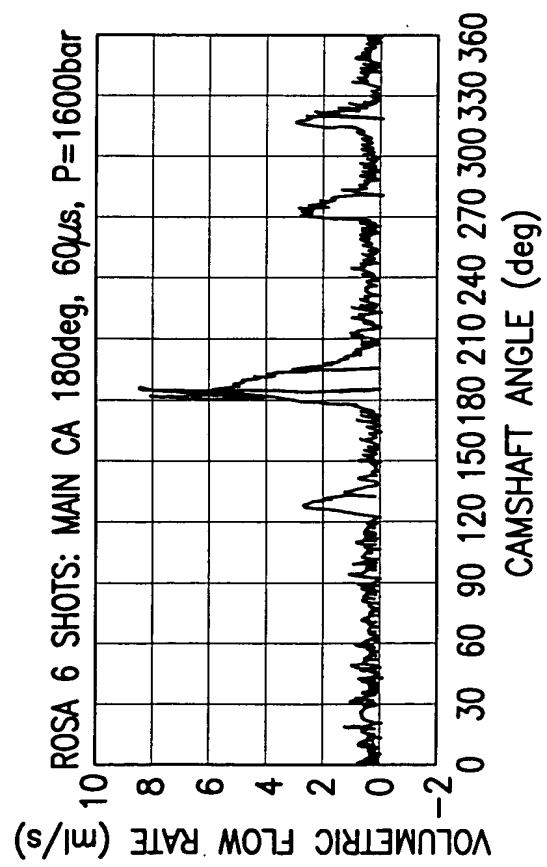
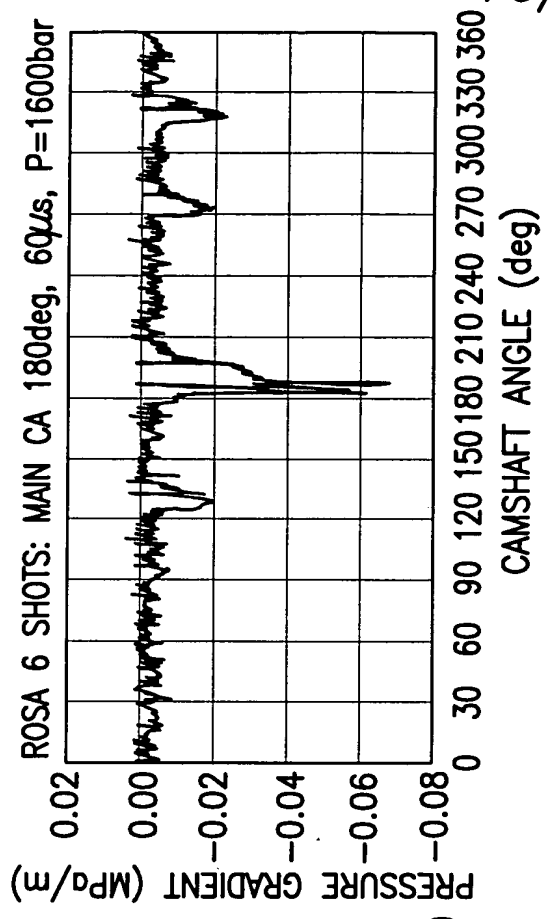
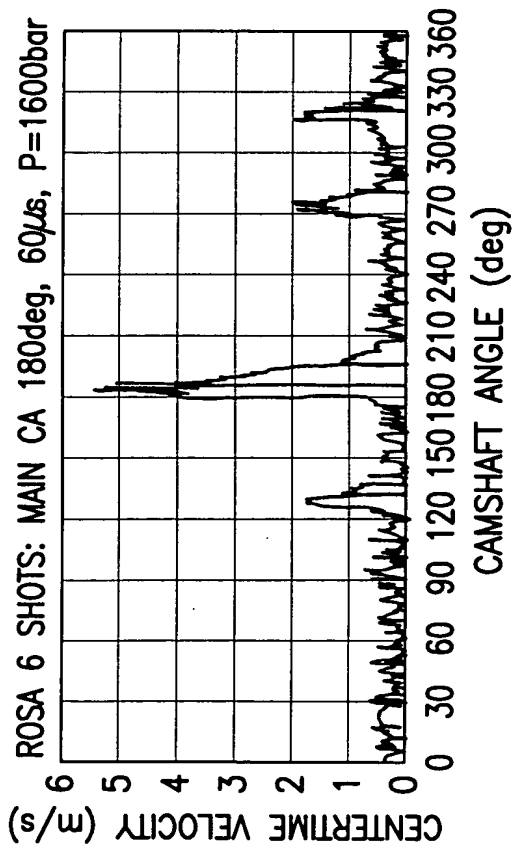


FIG.66



69/72

FIG.67



70/72

FIG.68

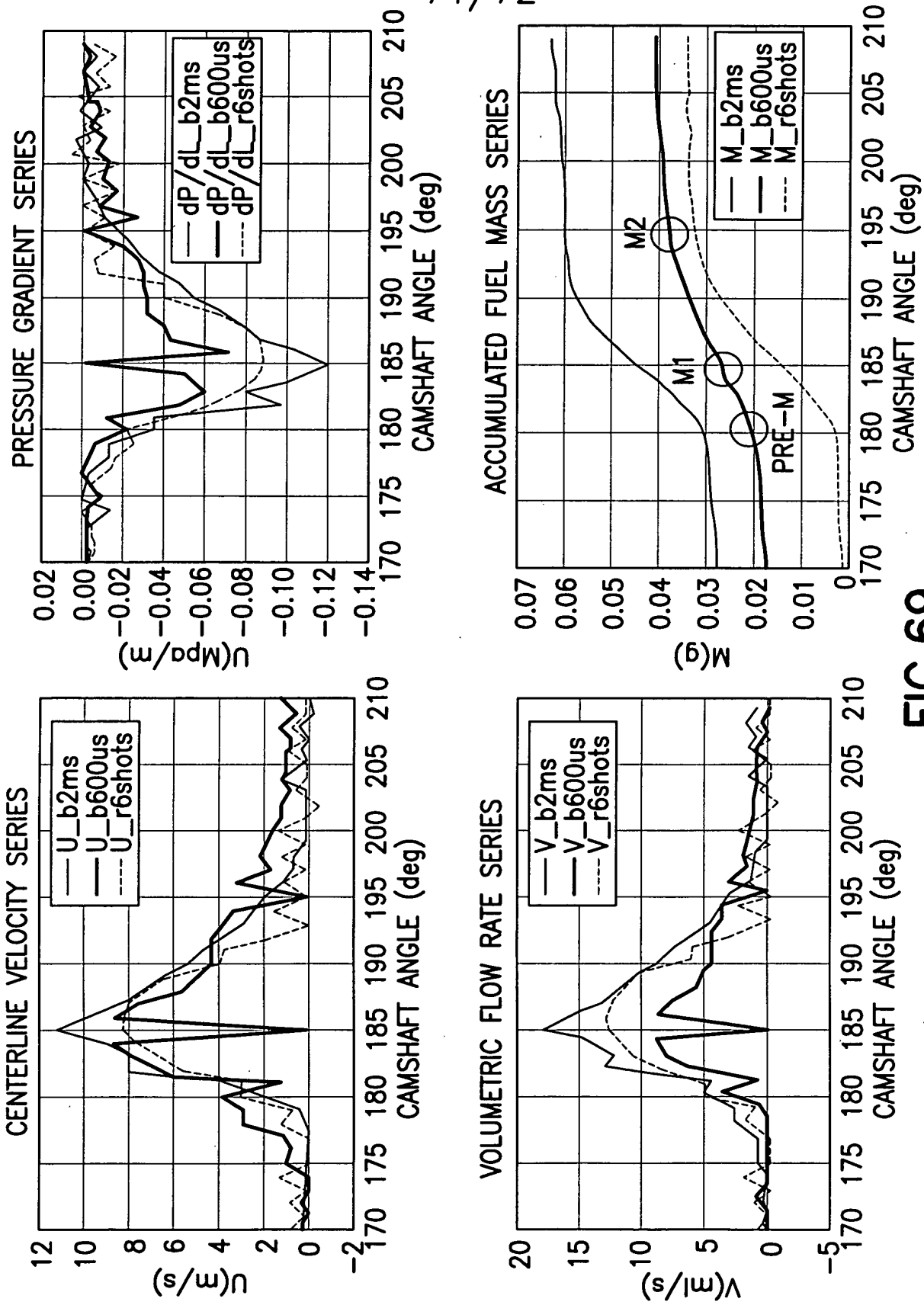


FIG.69

72/72

	SHOT/PASS	START deg	END deg	DURATION ms	MASSES mg	% OF TOTAL %
1	DELIVER 1	0	125	34.72	10.74	14.8
2	PILOT	125	133	2.22	4.18	5.8
3	DELIVER 2	133	175	11.67	4.33	6.0
4	PRE-MAIN	175	182	1.94	4.47	6.2
5	MAIN 1	182	186	1.11	7.30	10.1
6	MAIN 2	186	196	2.78	11.65	16.1
7	DELIVER 3	196	269	20.28	10.62	14.7
8	AFTER-M	269	281	3.33	5.81	8.0
9	DELIVER 4	281	315	9.44	5.02	6.9
10	POST	315	327	3.33	4.76	6.6
11	DELIVER 5	327	360	9.17	3.54	4.9
	TOTAL:				72.42	100.0
	INJECTED				38.17	52.7
	DELIVER				34.25	47.3

FIG.70